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ANNUAL REPORT-1972, NATIONAL ENVIRONMENTAL RESEARCH CENTER RESEARCH TRIANGLE PARK, NORTH CAROLINA

National Environmental Research Center

Prepared for:

Environmental Protection Agency

June 1973

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U. S. ENVIRONMENTAL PROTECTION AGENCY

ANNUAL REPORT 1972

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Monitoring
National Environmental Research Center
Research Triangle Park, North Carolina 27711
June 1973

"EPA IS A NEW DEPARTURE, A FRESH START TO RESTORE THE DELICATE BALANCE WHICH SUPPORTS LIFE ON THIS PLANET. IT IS A NEW, INTEGRATED APPROACH TO THE ENVIRONMENTAL CRISIS . . . WE ARE GOING TO INSIST, WITH THE AUTHORITY THAT CONGRESS HAS PROVIDED, AND WITH ALL THE POWERS OF PERSUASION AT OUR COMMAND, THAT ALL EXISTING MEANS FOR CONTROLLING POLLUTION BE APPLIED, ACROSS THE BOARD, IN EVERY CITY AND TOWN AND TO EVERY INDUSTRY IN THIS COUNTRY. WE INTEND TO PURSUE A VIGOROUS ENFORCEMENT PROGRAM AS THE FOUNDATION OF OUR WHOLE EFFORT IN POLLUTION CONTROL."

Figure 1. William D. Ruckelshaus, former EPA Administrator.

PREFACE

NATIONAL ENVIRONMENTAL RESEARCH CENTER

Research Triangle Park, North Carolina

Our President set a national goal when he stated, "The 1970's absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters, and our living environment." We cannot fulfill this goal unless our pollution control efforts are based upon sound scientific information. The Environmental Protection Agency's Office of Research and Monitoring has entrusted our Center and three others with the responsibility of providing needed scientific information. To do this, we must work closely with other research groups in government, industry, and universities. As you read this Report, you will learn more of the problems we face and what is being done about them. When you have finished, we would welcome your comments and questions.

John F. Finklea, M.D.
Director

June 1973

Figure 2. National Environmental Research Center, Research Triangle Park, North Carolina.

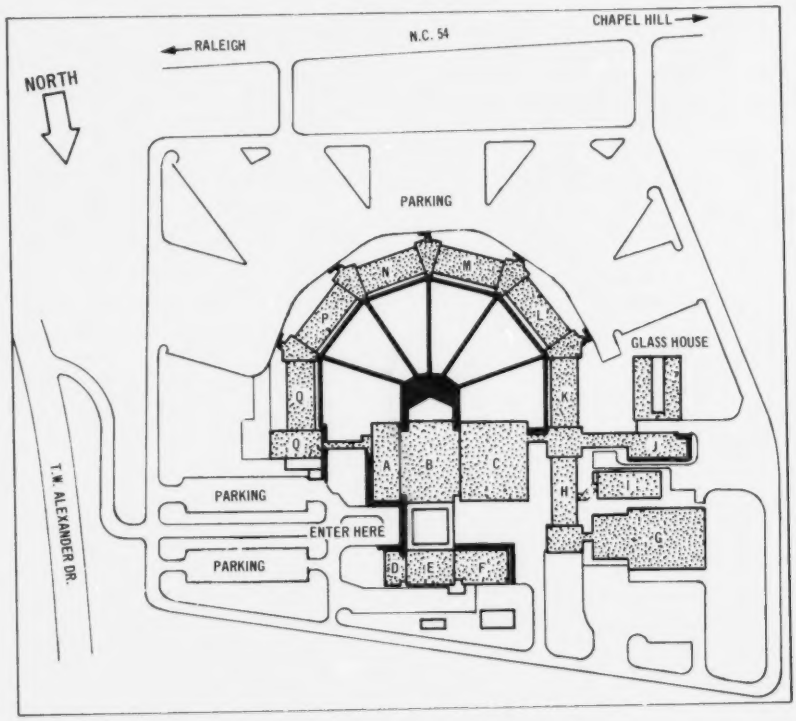

Figure 3. Plan view of NERC/RTP.

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Section 1. EXECUTIVE SUMMARY

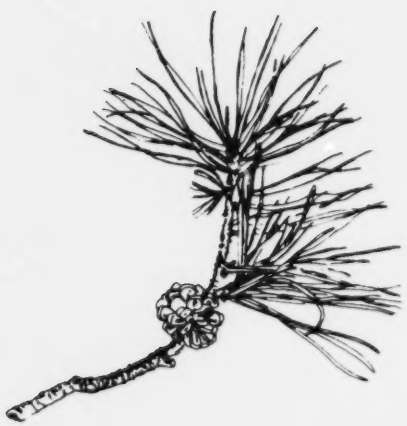


Figure 4. Exposure of participant in carbon monoxide study.

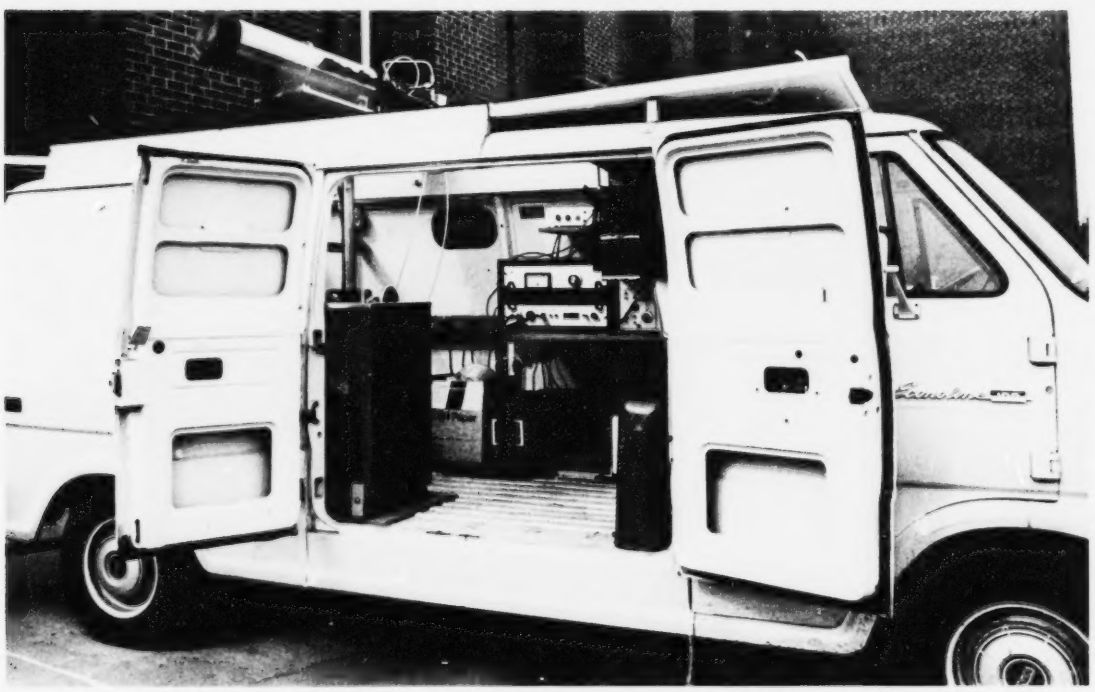


Figure 5. Mobile Lidar System designed for remote measurement of stack plume opacity.

NERC/RTP ANNUAL REPORT—1972

Section 1

EXECUTIVE SUMMARY

Programs of the Environmental Protection Agency's National Environmental Research Center/Research Triangle Park (NERC/RTP) are directed toward the acquisition of knowledge in several areas – knowledge that can be utilized to effectively improve the environment of the United States. These areas include instrumentation and methodology development, health effects studies, pollution abatement technology, and predictive modeling studies. This summary briefly reviews NERC/RTP's major accomplishments in these areas for the period of this Report and points up the future direction of its programs.

The Community Health and Environmental Surveillance System (CHESS), a program being conducted by the Human Studies Laboratory, evaluates existing environmental standards, obtains health intelligence for new controls, and documents the health benefits of current controls. CHESS also integrates a series of epidemiologic investigations with a comprehensive assessment of environmental exposure. Significant findings already reported include the observation that aggravation of asthma and chronic cardiorespiratory diseases often follows exposure to elevated levels of suspended atmospheric sulfates. This adverse effect is much stronger than the effect associated with exposure to sulfur dioxide or total suspended particulate matter. Another finding is that the frequency of chronic respiratory disease symptoms significantly increased in residents exposed to urban air pollution for several years. This effect is about one-third of the adverse effect attributable to cigarette smoking. (See the Special Features article on CHESS in Section 3.) Additionally, clinical investigation by the Laboratory shows that low-level carbon monoxide exposure enhances the preclinical and clinical signs of arteriosclerotic heart disease in exercise-stressed subjects. Other projects include the assembly of a national tissue bank and projected future studies of human exposures to gaseous pollutants, noise, and non-ionizing radiation.

The Experimental Biology Laboratory, in its investigations of microwave irradiation effects, completed several instrumental developments, one of which was the calibration of its 2450-MHz microwave generator. Although several biological studies have revealed microwave-induced effects at the cellular level, much of the work thus far has been in preparation for subsequent investigations such as one to examine the repair capacity of mammalian cells subjected to environmental stresses.

At the Primate and Pesticides Effects Laboratory, new methodology and instrumentation were developed for assessing the impact of pesticides on human health. Included were equipment modifications for monitoring pesticides both in humans and in environmental media, procedures for determining pesticides in blood, methods to determine man's exposure to a spectrum of biodegradable pesticides, and development of methodology for detecting trace metals in human tissue and excreta. The characteristic hexachlorophene-induced brain lesion was produced in Squirrel monkeys and was correlated with a deficit in visual-evoked

response. Follow-up studies have indicated no increase in the trend of the storage of DDT in fatty tissue of America's general population since the earliest survey in 1950. The teratology program of the National Center for Toxicological Research was also established. Future activities will include determining pesticide effects on certain internal body organs and processes as well as developing improved analytical methodology.

The Chemistry and Physics Laboratory has developed instrumentation for the measurement of gaseous pollutants, including chemiluminescent devices for measuring ozone, nitric oxide, and nitrogen dioxide. Additional improved instrumental and laboratory measurement techniques were developed for stationary and mobile source emission testing. Ambient air measurement instruments for aerosols are also being developed. Detailed hydrocarbon analyses in four American cities established vehicular and non-vehicular emission levels for use in developing EPA emission control strategies. Modeling efforts were undertaken to mathematically describe and predict the smog potential in urban areas.

The Control Systems Laboratory's major concern has been with the control of sulfur oxides from fuel combustion; about 80 percent of its expenditures to date have been in that area and have been concentrated on flue gas cleaning. The success of this program will permit the economic utilization of essentially all of the coals of the Eastern and Midwestern United States under New-Source Performance Standards, compared with the present utilization rate of only 7 percent of these coals in their natural condition. Commercialization of these techniques is in progress; four prototype demonstrations are under way, and three more are scheduled. The control of nitrogen oxides in coal combustion is another area of major effort. The Laboratory's field testing program, under way since early 1971, is substantially ahead of schedule, and engineering research and development now under way is expected to permit the attainment of National New-Source Performance Standards by early 1975. The Laboratory has also achieved success in the area of technology associated with coke making. A current prototype demonstration is expected to achieve reduction of pollutants from this process by 90 percent, permitting effective control of the worst polluting process of the iron and steel industry, itself a major air polluter. Other Laboratory programs in progress include efforts to control both particulates and hazardous (and potentially hazardous) pollutants.

Another NERC program of nationwide interest is the Regional Air Pollution Study (RAPS) being conducted in St. Louis under the direction of the Meteorology Laboratory. Initiated in July 1972, the 5-year research program will be a means of validating and improving models describing atmospheric processes, including temporal and spatial distributions in an air quality region. A series of field investigations on a regional scale will be conducted in the St. Louis area. (See the Special Features article on RAPS in Section 3.)

In addition to its direction and input to RAPS, the Meteorology Laboratory has developed or improved several mathematical models for air pollutants covered by the National Ambient Air Quality Standards. The models attempt to describe the dispersion of air pollutants in populated areas and the relationship of air quality measurements to Air Quality Standards. Additional modeling studies are planned, along with implementation of the Physical Modeling Facility and its wind tunnel. A User's Network for Environmental Quality Modeling is also under development. The Laboratory provides emergency support, in the form of special weather forecasts and meteorological observations, during local stagnation episodes and during accidental spills of hazardous materials. Two examples of activities in this area were the Birmingham, Alabama, stag-

nation episode, which resulted in a strict curtailment of industrial emissions, and the Louisville, Kentucky, threat of a massive accidental chlorine gas release, which caused evacuation of part of that city.

To make air monitoring data more accessible, the Quality Assurance and Environmental Monitoring Laboratory established a nationwide air quality data management system that receives a major portion of air quality data acquired by Federal, State, and local agencies. The evaluation and collaborative tests of the **Federal Register** reference methods for SO_2 and CO were completed. A major effort was initiated to prepare for instituting quality control in Regional, NERC, State, and local environmental monitoring programs. New investigations will involve development of better monitoring techniques for the more-difficult-to-analyze pollutants, for new generation pollutants, for ambient-air/source relationships, and for particle size distribution. Emphasized, too, will be the evaluation of recently introduced sampling and analytical methods for the measurement of nitrogen oxides in ambient air.

At the Eastern Environmental Radiation Laboratory, a study based on the exposure of mature hamsters to 200 MW/cm^2 at a frequency of 2432 ± 4 MHz demonstrated that microwave radiation can induce chromosome abnormalities. Biological studies exposing guinea pigs to krypton-85 are being conducted to develop credible standards for krypton-85 concentrations in ambient air and for release to the environs by nuclear facilities. Radiochemical procedures were developed for the analysis of environmental samples for plutonium, neptunium, and curium. Investigations will continue in these areas by studying various parameters of microwave exposure, completing some of the krypton-85 bioeffects studies and initiating others, and expanding the radiochemical and instrumental methodology studies to include other nuclides in environmental samples.

The Division of Ecological Research completed state-of-the-art surveys on stress corrosion of metals and developed techniques for evaluating air pollution damage to paints. Other studies include a report on the biological effects of 15 heavy and/or trace elements on the environment and a study of the ecological effects of fluorides.

Figure 6. Control panel for microwave generator utilized in low-level exposure studies with Chinese hamsters.

TECHNICAL INFORMATION DISSEMINATION

NERC/RTP endeavors to disseminate, as rapidly as possible, newly developed information through the holding of technical meetings and the presentation and publication of technical reports. NERC Laboratories have sponsored at least six major technical events since August 1971; listed chronologically, they are:

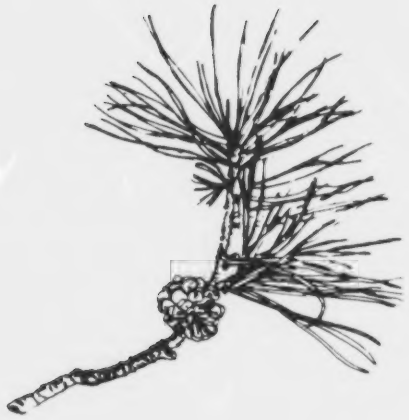
- The Second International Lime/Limestone Wet-Scrubbing Symposium, held

November 8-12, 1971, in New Orleans under the sponsorship of the Control Systems Laboratory. The more than 50 papers presented dealt with five aspects of wet-scrubbing: fundamental research, pilot-scale research and development, prototype and full-scale tests, and scaling, sampling, and analytical methodology.

- Flame Day, U.S.A., held September 6-7, 1972, in Chicago under the cosponsorship of the Control Systems Laboratory. Scientific papers presented at the meeting dealt with the practical applications of knowledge and new data as well as with the immediate problems of design and operation of stationary combustions sources to meet present and impending controls.
- The American Medical Association's Air Pollution Medical Research Conference, held October 2-3, 1972, in Chicago under the cosponsorship of the Human Studies Laboratory. Participants at this Conference reviewed the latest knowledge concerning human illness related to air pollution. Related topics included familial and inherited response to air pollution, the effects of air pollution on children, and epidemiological studies.
- The Third International Conference on Fluidized-Bed Combustion, held October 29-November 1, 1972, in Hueston Woods, Ohio, under the sponsorship of the Control Systems Laboratory. The more than 30 papers presented, as well as the closing panel discussion, dealt with such aspects of fluidized-bed combustion as coal combustion and additive research, non-coal fluidized-bed combustion processes, gasification/desulfurization, conceptual designs and economics, and pilot plant design, construction, and operation.
- Photochemical Modeling Workshop, held October 30-31, 1972, at NERC/RTP under the sponsorship of the Chemistry and Physics Laboratory. In addition to developing future directions of the Laboratory, the Workshop established better lines of communication between experimentalists and modelers. Topics discussed were elementary rate constants, reaction mechanisms, smog chamber research, and atmospheric measurements that are required for model verification.
- Aerosol Chemisorption Conference, held December 7-8, 1972, at NERC/RTP under the sponsorship of the Chemistry and Physics Laboratory. EPA scientific personnel and recipients of EPA/CLP-sponsored research grants in related areas discussed progress made in each grant area. Emphasis was on the direction of objectives that must be pursued in the future

A quantitative indicator of NERC/RTP's scientific output is the large number of technical presentations and publications emanating from its investigations. The Center's scientists gave 232 presentations and published 260 scientific reports during the period of this Report, a list of which is planned for issuance as a supplement to this Report.

Section 2. INTRODUCTION



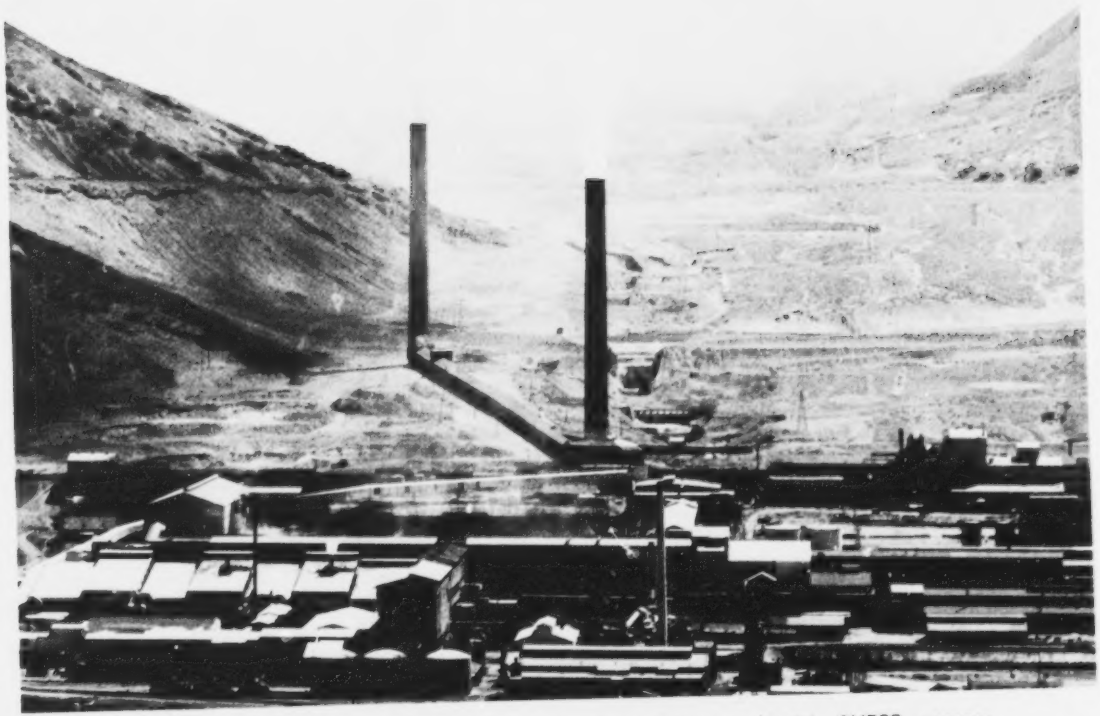


Figure 7. Copper smelter located in one of several areas involved in CHESS program.

Section 2

INTRODUCTION

PURPOSE

Our intent in publishing this, our first Annual Report, is twofold:

FIRST, to introduce NERC/RTP (National Environmental Research Center/Research Triangle Park, North Carolina) to the national and international spectrum of people and professions interested in a cleaner environment; and

SECOND, to tell you something of our history, organization, accomplishments, current endeavors, and general goals.

Annual reports normally highlight the accomplishment of organization over the past year. Although that characteristic applies to this Report, there is another function: the Report is also a working document a reference, on the individual NERC/RTP Laboratories and their current programs.

Thus, Sections 1, 2, and 3 discuss NERC/RTP generally – a program summary for the past year, its mission, history, organization, and highlighted projects. Section 4 presents more detailed information on the Director's Office and on each NERC/RTP Laboratory – its composition, facilities, progress made in its current programs, and emphasis being placed on future programs.

This Report covers the activities of the Center from the time of its formation in August 1971 through December 1972. A supplement is being prepared listing the publications and presentations of each Laboratory for this period.

MISSION

The Environmental Protection Agency (EPA) was created on December 2, 1970, to protect and enhance the living environment of our Nation. This mission, to provide a better environment, is the basis for the charge of the Office of Research and Monitoring (OR&M) – to furnish EPA with the knowledge to (1) establish environmental controls based upon existing or potentially adverse effects, and (2) define and develop techniques to achieve a wholesome environment.

OR&M accomplishes its plans through the operation of four National Environmental Research Centers located in Cincinnati (Ohio), Corvallis (Oregon), Las Vegas (Nevada), and Research Triangle Park (North Carolina). The Center in North Carolina conducts research and development programs to provide EPA with scientific and technological bases for the establishment of criteria and standards, and with pollution control technologies to alleviate or deter adverse effects, primarily upon human health. These programs place emphasis on four major research activities:

- The development and standardization of techniques for the measurement of pollutants, both at their source and in the ambient environment.
- The quantification of the effect of human exposure to environmental pollutants on both health and welfare.
- The development of cost-effective control technologies.

- The development of predictive models for environmental levels of pollutants through an understanding of pollutant emissions, transport, transformation, and removal.

NERC/RTP CAPABILITIES

NERC/RTP constitutes one of the largest multidisciplinary research groups in existence concentrating its efforts on solving environmental problems. The knowledge obtained by the Center will be the basis for standards of quality to ensure a healthful, aesthetically enhanced environment.

Research Programs

NERC/RTP has already established itself as a center of excellence in certain areas of pollution research and is developing expertise in several others.

- **Air Pollution** – The Center conducts a comprehensive air pollution research and monitoring program. Research focuses on both long- and short-term effects of air pollutants, sampling and measurement methodology, the formation and decay of pollutants, air pollution meteorology, and control technology research, development, and demonstration relating to stationary sources. In addition, the Center maintains and operates a national air monitoring program and a national environmental data information service, develops environmental quality criteria and state-of-the-art documents, and operates EPA's fuel and fuel additives registration program.
- **Pesticides** – Research is focused on the development of more adequate analytical methods and on the pharmacology and toxicity of these chemicals.
- **Ionizing and Non-Ionizing Radiation** – Because the Center has a major interest in the ionizing radiation from nuclear power and reprocessing plants, it maintains programs to develop measurement techniques for low levels of radiation in air and water as well as in food and soil. Effects research places emphasis on carefully selected toxicology and epidemiology studies needed for setting standards. Research is also conducted to ensure that adverse effects will not arise from current and projected exposures involving non-ionizing radiation.
- **Noise and Toxic Substances** – The Center will be involved in conducting the research necessary to implement the recent Noise Control Act as well as pending legislation on toxic substances.

Human Resources

The professional, technical, and clerical staff at the Center numbers 626. Table 1 describes the variety of expertise present.

Figure 8. Investigator researching biological effects of pesticides.

HISTORY

EPA was created by executive order of President Nixon in December 1970. It was designed by the President's Advisory Council on Executive Organization, chaired by Roy Ash of Litton Industries, as a regulatory agency, with primary responsibilities for establishing and enforcing environmental

Table 1. NERC/RTP PROFESSIONAL STAFF

Discipline	BS	BA	MS	MA	DVM	ScD	MD	PhD	Totals
Biological and agricultural sciences	20	5	16	3				12	56
Chemistry	48	8	25			1		33	115
Engineering	36	1	38					15	90
Health fields			7		9	1	20	10	47
Mathematical sciences	11	6	14			1		4	36
Physical sciences	8	1	29	1				10	49
Other	6	8	3	2				3	22
Totals	129	29	132	6	9	3	20	87	415

standards within the limits of its various statutory authorities.

The Council believed that the key standard-setting functions should be performed outside of agencies whose other interests might either affect or be affected by those standards. Accordingly, EPA was established as an independent agency, bringing together, in one central unit, the various anti-pollution programs already established in more than a dozen different agencies. These programs dealt with the most urgent environmental problems in the United States – those which pose immediate threats to human health: impure water, polluted air, solid waste disposal, pesticides and other toxic substances, and ionizing radiation. Since the inception of the Agency, a noise pollution program has been added to the five principal programs that make up EPA.

The Council determined that the standard-setting function should not stand alone; for the standards to be soundly based requires a research capability; to determine if the standards are being complied with requires a monitoring capability. The Council was careful, however, to identify for transfer to EPA only those research functions that the new Agency would need to fulfill its mission – indeed, only those programs demonstrably essential to EPA's functioning as a regulatory agency. The result is a lean organization – lean not only in terms of regulatory authority, but also in terms of in-house and extramural allocatable resources. While nearly $1 billion will be spent by Federal agencies in 1973 on environment-oriented research, the total budget currently applied to EPA's research and technological advancement function is only a little over $165 million a year. Within this budget, EPA must provide the competence to convert research into standards and also to suggest needed research so that, while EPA does not conduct all of the research, it must ensure that "everything" is being done.

Established by EPA in August 1971, NERC/RTP has been in operation just more than a year. Construction of the Center began in 1969; Julie Nixon Eisenhower and EPA Administrator William B. Ruckelshaus participated in the official dedication of the Center on December 10, 1971. The third of four National Environmental Research Centers to be dedicated, it was assigned the general theme of environmental health effects research.

The Center is located in Research Triangle Park, North Carolina, an area between Durham, Raleigh, and Chapel Hill. The major universities of these cities provide specialized resources which complement those of the Center. The National Institute of Environmental Health Sciences of the Department of Health, Education, and Welfare (DHEW) was also located in the Research Triangle Park so that Federal environmental research programs might be better coordinated.

The present 300,000-square-foot, $10.5-million building (containing 200 laboratories) is being leased for 20 years. Certain non-laboratory functions and administrative support are located in Durham. Plans call for the eventual construction of a permanent, government-owned facility at Research Triangle Park.

When Dr. Stanley M. Greenfield, EPA's Assistant Administrator for Research and Monitoring, established NERC/RTP, the Bureau of Air Pollution Sciences (BAPS), headed by Dr. Delbert S. Barth and already located in North Carolina, became the core organization. In August 1971, Dr. Barth became NERC/RTP's first Director.

Subsequent to the formation of NERC/RTP, three major associated laboratories were assigned to the Center. The Twinbrook Radiation Laboratory (Rockville, Maryland) and the Eastern Environmental Radiation Laboratory (Montgomery, Alabama) were formerly under DHEW's Bureau of Radiological Health. The Perrine Primate Laboratory (Florida) – with its Chamblee Toxicology Laboratory (Georgia) and Wenatchee Field Research Station (Washington) – was under the U. S. Food and Drug Administration. Twinbrook was relocated to North Carolina in August 1972.

In 1972 NERC/RTP had a total of 626 employees and an operating budget of $62.7 million. Following Dr. Barth's transfer to NERC/Las Vegas, Dr. John Finklea was appointed Director in September 1972.

ORGANIZATION

Recently reorganized to reflect more unified operation and to more clearly designate component activities and functions, NERC/RTP consists of staff offices and Laboratories depicted in the organization chart. Directors of the component organizations can be contacted as indicated by the locator chart. The new organizational titles are used in this Report, although individual program descriptions of their 1972 accomplishments reflect the former organizational format.

Functions of the various NERC/RTP components are outlined in the following subsections.

Human Studies Laboratory

Known formerly as the Division of Health Effects Research, the Human Studies Laboratory (HSL) conducts studies to define the dose-response relationships between environmental pollutants and specific undesirable effects. These studies include both clinical and epidemiological investigations. Major emphasis is placed on collecting sufficient information to (1) formulate, evaluate, and revise environmental quality criteria, and (2) assess the health impact of control technology. The Laboratory provides vital health

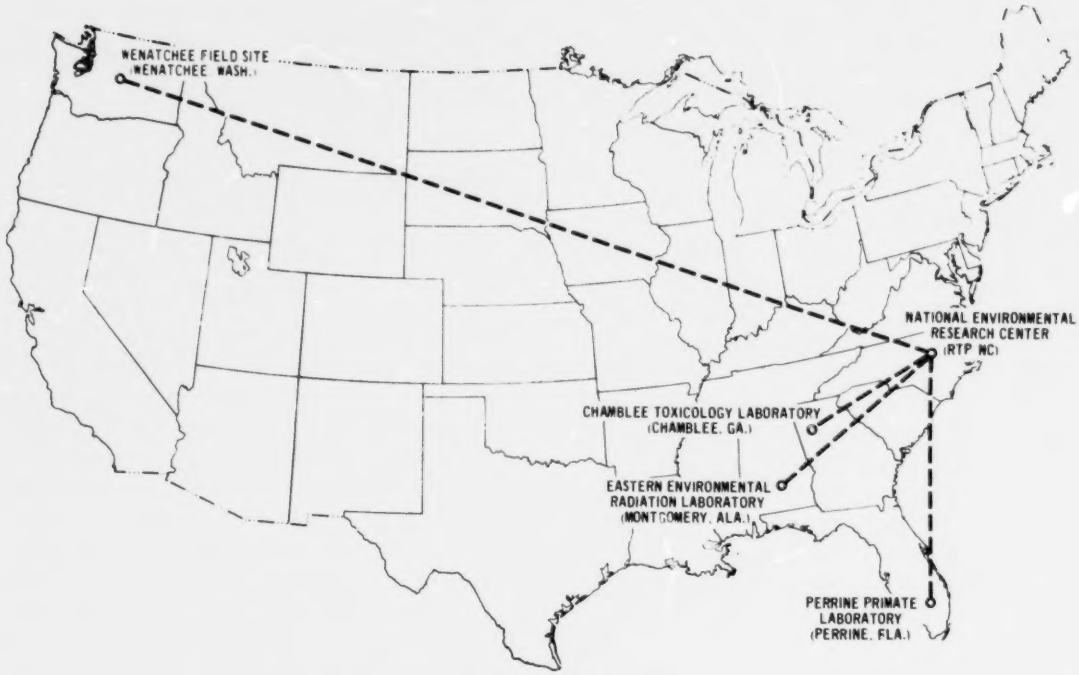
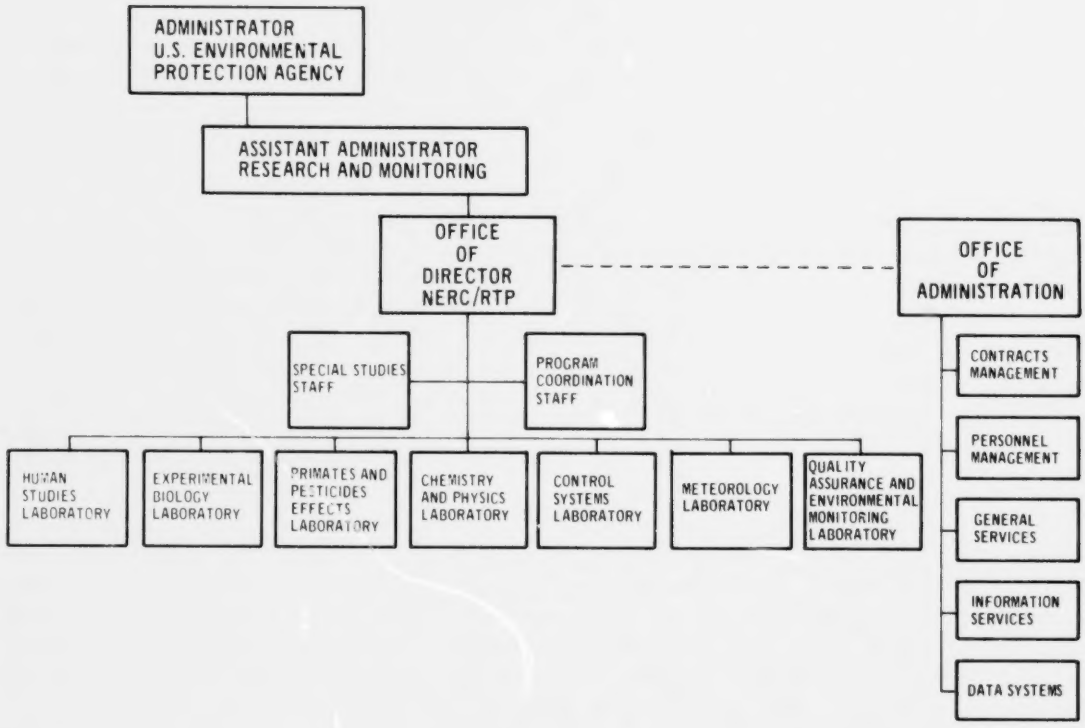


Figure 9. Location of NERC/RTP associate laboratories.



intelligence for the control of environmental pollutants which may adversely affect human health. Health intelligence is based upon carefully designed sets of human and toxicologic experiments that deal with specific problems.

Experimental Biology Laboratory

Formerly called Twinbrook Radiation Laboratory, the Experimental Biology Laboratory (EBL) conducts and manages biological research designed to detect, define, and quantify the effects of environmental pollutants. This research involves laboratory studies of intact animals or cellular and subcellular systems living in a controlled and simulated environment. Major emphasis is placed on developing information for formulating and revising environmental quality criteria in support of human health studies.

Primate and Pesticides Effects Laboratory

Known previously as the Perrine Primate Laboratory, the Primate and Pesticides Effects Laboratory (PPEL) conducts research to provide data for the intelligent assessment of the hazard to human health caused by exposure to single pesticides, to combinations of pesticides, and pesticides in combination with other environmental factors. The studies are concerned with identifying pesticides, their metabolites, and any adverse effects on normal biological functions. The Laboratory evaluates and improves the techniques and chemical mehtods for direct and indirect measurement of exposure to pesticides.

The Bioeffects Branch, using non-primates, conducts acute toxicology studies on the human health hazards of pesticides. The Branch also studies the methods of diagnosing poisoning cases and provides analytical services to Federal, State, and local health officials in suspected cases of pesticide poisoning.

The Wenatchee Research Station investigates occupationally and environmentally exposed individuals under conditions of actual field usage of pesticides.

Chemistry and Physics Laboratory

The Chemistry and Physics Laboratory (CPL) conducts a research and development program in the chemistry and physics of environmental control. The Laboratory develops instruments and techniques for the measurement of environmental contaminants, including air pollutants covered by National Ambient Air Quality Standards, New-Source Performance Standards, Emission Standards for Hazardous Pollutants, and Mobile Source Emission Standards. Other environmental contaminants measured include radioactive materials, aeroallergens, and aerocarcinogens. The Laboratory also determines the chemical and physical transformations that pollutants undergo from source to receptor in the atmosphere, and develops and applies methodology for characterizing and determining the physical effects of the emissions associated with the use of fuels and fuel additives. Lastly, CPL conducts research on the effects of pollutants on materials.

Control Systems Laboratory

The Control Systems Laboratory (CSL) conducts, directs, and manages engineering research, development, and demonstration programs leading to the abatement of air pollution from all stationary sources. Laboratory activities encompass development and improvement of control devices such as scrubbers, filters, and electrostatic precipitators; complete effluent gas treatment processes; combustion methods and equipment; fuel preparation technology; and associated sampling and analysis instrumentation systems. CSL also provides additional support in the areas of emissions forecasting, control strategies, and national energy policies.

Meteorology Laboratory

The Meteorology Laboratory (MTL) develops and conducts research concerned with the meteorological aspects of air pollution, including theoretical and experimental studies of the physical processes affecting the transport, diffusion, transformation, and disposition of air pollutants in and from the atmosphere. The Laboratory develops and improves techniques and methods to forecast potential air pollution episodes; develops analytical diffusion models to predict the temporal and spatial distribution of air pollutants; conducts studies on the effects of air pollutants on the geophysical processes of weather and climate, as well as the energy balance of the earth-atmosphere system; develops remote sensing techniques for measuring meteorological parameters in urban areas; and provides meteorological services to other EPA activities.

Quality Assurance and Environmental Monitoring Laboratory

Formerly known as the Division of Atmospheric Surveillance, the Quality Assurance and Environmental Monitoring Laboratory (QAEML) provides laboratory and technical service capability for the analysis of environmental samples for a variety of trace elements and other substances. It provides specialized monitoring field support teams and technical assistance support to EPA Regional Offices and to local air pollution control agencies. Furthermore, the Laboratory operates the nationwide fuel surveillance network, standardizes air pollution measurement methods, and ensures the quality of the air monitoring activities mandated by the Clean Air Act.

Division of Ecological Research/Eastern Environmental Radiation Laboratory

The Division of Ecological Research (DER) was transferred to NERC/Corvallis in January 1973; its program description and activity summary will be reported by NERC/Corvallis. Projects conducted under NERC/RTP functions located at the Eastern Environmental Radiation Laboratory are reported in Section 4 of this Report.

FUNDING SUMMARY

Table 2 summarizes the funding and positions allotted to NERC/RTP Laboratories during Fiscal Years 1972 and 1973. The funding, reflecting the increasing emphasis being placed on solving environmental pollution problems, includes that from all sources – direct operations, contracts, grants, and interagency agreements. For Fiscal Year 1971, NERC/RTP Laboratories operated on a budget of $52,413,000 with 752 employees. That same year, the Center had an additional 82 "temporary" employees, a number that was reduced to 64 by Fiscal Year 1972.

Table 2. SUMMARY OF RESOURCES FOR ALL NERC/RTP LABORATORIES FOR FISCAL YEARS 1972 and 1973

Component	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
Director's Office	1,678/32	1,460/31
Human Studies Lab	5,030/109	8,223/106
Experimental Biology Lab	2,223/63	2,254/50
Primate and Pesticides Effects Lab	2,616/85	2,658/85
Chemistry and Physics Lab	9,871/89	8,829/83
Control Systems Lab	24,026/95	27,011/95
Meteorology Lab	3,777/13	6,196/15
Quality Assurance and Environmental Monitoring Lab	3,229/103	3,496/92
Eastern Environmental Radiation Lab[a]	773/34	806/43
Division of Ecological Research[b]	2,022/30	1,815/26
Totals	55,245/653	62,748/626

[a]Includes only those projects conducted under NERC/RTP functions located at EERL.

[b]The Division of Ecological Research was transferred to NERC/Corvallis in January 1973.

NERC/RTP LOCATOR CHART

Organization	Abbreviation	Director	FTS Phone No.	Address
National Environmental Research Center, RTP	NERC/RTP	John F. Finklea	(919) 549-2281	Research Triangle Park, N. C. 27711
Human Studies Lab	HSL	Carl M. Shy	(919) 549-2242	Research Triangle Park, N. C. 27711
Experimental Biology Lab	EBL	R. John Garner	(919) 549-2771	Research Triangle Park, N. C. 27711
Primate and Pesticides Effects Lab	PPEL	William F. Durham	(305) 350-2251	Box 490, Perrine, Fla. 33157
Chamblee Toxicology Lab	CTL	Renate Kimbrough	(404) 633-5216	4770 Buford Hwy., Chamblee, Ga. 30341
Wenatchee Research Station	WRS	Homer R. Wolfe	(509) 663-8331	P.O. Box 73, Wenatchee, Wash. 98801
Chemistry and Physics Lab	CPL	A. Paul Altshuller	(919) 549-2191	Research Triangle Park, N.C. 27711
Control Systems Lab	CSL	John K. Burchard	(919) 688-8335	Research Triangle Park, N. C. 27711
Meteorology Lab	MTL	L. E. Niemeyer	(919) 549-4541	Research Triangle Park, N. C. 27711
Quality Assurance and Environmental Monitoring Lab	QAEML	S. David Shearer	(919) 549-2106	Research Triangle Park, N. C. 27711

Section 3. SPECIAL FEATURES

Section 3

SPECIAL FEATURES

Several of the Center's people and programs are of special interest because of their actual and potential impact on the solution of environmental problems. From several possibilities, this Section focuses on one of NERC/RTP's outstanding scientists, Dr. A. Paul Altshuller, and three of the Center's ongoing programs of significance: the Community Health and Environmental Surveillance System (CHESS), the Regional Air Pollution Study (RAPS), and demonstrations of emission controls for sulfur oxides.

A. PAUL ALTSHULLER

During the past 10 years, one of the more important areas of research in air pollution control has been that of the chemistry of atmospheric pollutants. Dr. A. P. Altshuller has personally conducted and supervised a wide range of work on the nature of chemical reactions in the atmosphere. He has developed a comprehensive research and development program, giving special regard to the chemical and physical properties of air pollutants, their reactions, and their measurement. Under his leadership, the research program has grown from a modest section to the Center's Chemistry and Physics Laboratory with approximately 100 people and a research budget of about $9 million per year. He has built a strong, competent research group that has made significant contributions in many areas, including analytical techniques, instrumentation, reaction kinetics, and analysis of potential cancer-producing compounds in urban air.

Figure 10. Dr. A. Paul Altshuller, Director, Chemistry and Physics Laboratory.

Dr. Altshuller has published about 125 papers related to spectrophotometric analysis, gas chromatography, coulometric analysis, infrared spectrophotometry, photochemistry and kinetics, solution thermodynamics, statistical thermodynamics, thermochemistry, and various aspects of atmospheric chemistry. He has authored or co-authored several reviews of photochemical aspects of air pollution, photochemical reactivity, and atmospheric analysis. He was chairman of the ACS Committee on Air Pollution and the ACS

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Division of Water, Air, and Waste Chemistry. Dr. Altshuller received the Eighteenth Annual (1967) Cincinnati Chemist Award of the Cincinnati Section, American Chemical Society, and the Frank A. Chambers Award of the Air Pollution Control Association in 1970 for outstanding achievement. In 1971 he was awarded the Environmental Protection Agency Silver Medal for superior service. Dr. Alshuller is also on the editorial boards of **Atmospheric Environment** and **Chemosphere.**

Dr. Altshuller received his B.S. at the University of Chicago in 1948 and his M.S. and Ph.D. degrees in 1950 and 1951 from the University of Cincinnati. From 1951 to 1955 he was aeronautical research scientist engaged in fuels research with what is now the Lewis Research Center of NASA. Since 1955 he has held various research assignments in the air pollution program of the Public Health Service in Cincinnati. He assumed his present position, Director of the Chemistry and Physics Laboratory, in January 1969.

COMMUNITY HEALTH AND ENVIRONMENTAL SURVEILLANCE SYSTEM

The Community Health and Environmental Surveillance System (CHESS) is a national program of standardized epidemiologic studies organized within the past 3 years, designed to simultaneously measure environmental quality and sensitive acute and chronic health indicators in sets of communities representing exposure gradients to common air pollutants including particulates, sulfur oxides, nitrogen oxides, and photochemical oxidants.

The CHESS program now includes 33 neighborhoods in six areas of the country: New York-New Jersey, Chattanooga, Birmingham-Charlotte, St. Louis, Utah, and the Los Angeles Basin. The seven health indicators under surveillance in these neighborhoods include chronic respiratory disease in adults, acute lower respiratory disease in children,

Figure 11. Pulmonary function test using spirometer to measure lung capacity.

acute upper respiratory disease in families, daily asthma frequency, acute irritation symptoms during air pollution episodes, pulmonary function of school children, and tissue residues of cumulative pollutants in humans. In addition, daily aggravation of symptoms in subjects with pre-existing heart and lung disease is being followed in New York and Utah CHESS neighborhoods.

CHESS studies completed in the 1970-71 school year were analyzed and reported in 20 papers assembled into an EPA monograph entitled **Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971.** The studies revealed a wide range of subtle and overt adverse effects on the cardiorespiratory system to be attributable to pollutant exposure. Elementary school children were found to have measurable decreases in lung function; healthy respondents reported bothersome irritation during episodic elevations in pollutant levels; families living in more polluted communities reported more acute respiratory illness; panelists with chronic disorders such as asthma, chronic bronchitis, and heart disease reported aggravation of their symptoms when short-term air pollution exposures increased; and adults living in more polluted communities for

several years developed chronic bronchitis significantly more frequently than adults living in less polluted communities. In addition, the studies revealed the entirely new finding that adverse health effects are consistently associated with exposure to suspended sulfates, more so than to sulfur dioxide or total suspended particulate matter. The studies were also able to demonstrate both the benefit of improved air quality with respect to the chronic respiratory disease experience of subjects who moved out of New York City to lower-exposure communities, and the apparent beneficial effect of improvements in air quality in that city on ventilatory performance of younger children.

The above report focused on health effects of sulfur oxides. Analyses and reports of health effects produced by other pollutants being measured in CHESS are planned for the future.

The CHESS program is essential to evaluate existing environmental standards, to obtain health intelligence for new controls, and to document the health benefits of air pollution control.

CONTROL OF SULFUR OXIDES IN FLUE GAS

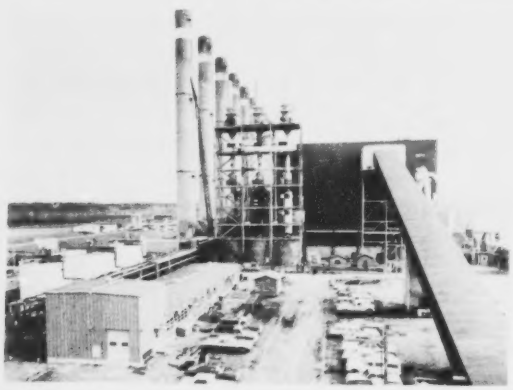

Figure 12a. Wet limestone scrubbing system at TVA Shawnee coal-fired power plant (Paducah, Kentucky).

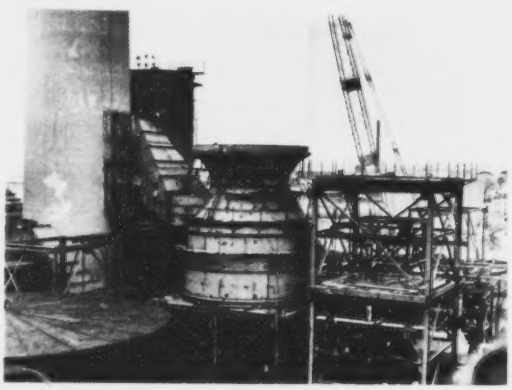

Figure 12b. Magnesium scrubbing system for SO_2 removal.

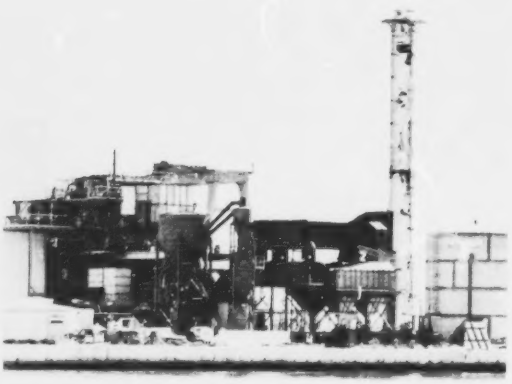

Figure 12c. Key West, Florida, oil-fired power plant using wet limestone scrubbing system.

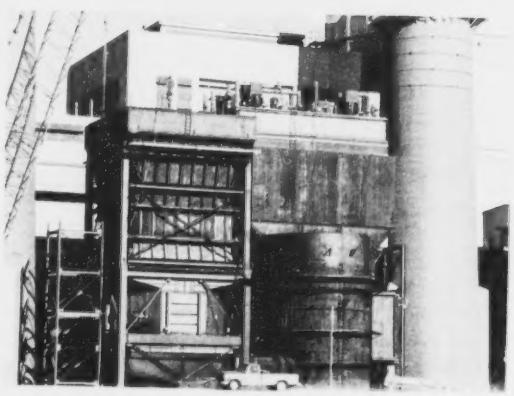

Figure 12d. Catalytic oxidation scrubbing system.

The four power plants shown here are Control Systems Laboratory (CSL) funded demonstrations representing the most advanced programs to control SO_x by flue gas treatment. Representing EPA funding totaling nearly $22 million to date (exclusive of local operations), these programs include:

- TVA's testing of three different lime/limestone prototype scrubbers utilizing by-product disposal in settling ponds.
- A regenerative scrubber process utilizing magnesium oxide with either a sulfur or a sulfuric acid by-product.
- The City of Key West's use of a fourth type of scrubber; this one uses a coral marl sorbent.
- Illinois Power's use of catalytic oxidation to produce sulfuric acid.

An already completed demonstration, not shown here, indicated the possibility of limited application of dry limestone injection. Other demonstrations of flue gas treatment processes, either under development or being actively considered by CSL, are:

- The Wellman Lord/Allied Chemical process, using sodium ion scrubbing with thermal regeneration to produce a sulfur by-product.
- The Stone & Webster/Ionics process, using sodium ion scrubbing with electrolytic regeneration.
- Ammonium bisulfate scrubbing.
- Activated char sorption.
- Double-alkali scrubbing.

REGIONAL AIR POLLUTION STUDY

The Regional Air Pollution Study (RAPS), a 5-year research program initiated in July 1972, will bring together a number of areas of research: air pollution effects, atmospheric processes, monitoring and analytical methods, ambient air quality surveillance, source characterization, and control strategies. A series of field investigations on a regional scale (over distances of the order of 100 kilometers) will be carried out in the St. Louis area. EPA will coordinate the RAPS with the experiments of other private groups and Federal agencies in the St. Louis area.

The RAPS is recognized as a means for EPA to demonstrate and evaluate how well the effectiveness of air pollution control strategies may be assessed and predicted within an air quality region, and to provide a basis for developing improved control strategies. Four principal objectives of the RAPS are:

- To evaluate the capability of mathematical air quality simulation models to describe and predict the transport, diffusion, and concentration of both inert and reactive pollutants over a regional area.
- To develop an improved understanding of the chemical, physical, and biological processes that are entailed in determining the concentration (the dispersal) of pollutants and the modification of air quality.
- To develop a better understanding of factors of significance to the design of improved control strategies in the urban/rural complex.
- To develop improved technology that can be applied in local and regional control agency operations.

The major data sources in the St. Louis area will be a very detailed emissions inventory and a network of instruments measuring air quality and meteorological parameters. Stationary sources will be studied to determine the chemical content, release schedule, and physical characteristics (such as release heights) of each significant emission. Air quality monitors will be installed and operated at some 30 fixed sites, and their data will be telemetered automatically to a central computer for immediate initial evaluation and storage. The fixed stations will be arranged in concentric circles of increasing radius from the Gateway Arch.

Other sources of information will include soundings by helicopter to determine the vertical distribution of pollution, balloon soundings of meteorological parameters, and aircraft sampling over wider ranges. Tracers will be added at selected sources to help identify pollutants for studies of mixing and of the chemical transformations resulting therefrom. These samples will then be promptly analyzed in nearby stationary or mobile laboratories.

Most of the RAPS functions will be contracted to private industry, with initial yearly funding of $5 million. Pending a successful RAPS in St. Louis, EPA will consider other Regional Studies in more complicated areas, e.g., coastal or mountainous regions.

Figure 13. St. Louis, Missouri - site of Regional Air Pollution Study.

Section 4. LABORATORY REPORTS

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Figure 14a. Mobile sampling vehicle.

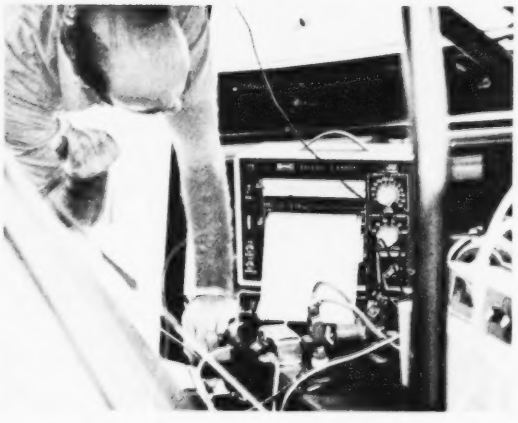

Figure 14b. Strip chart recorder indicating carbon monoxide concentrations outside of vehicle.

Figure 14c. Temperature sensor and transmitter used in tire-particulate-emission studies.

Section 4

LABORATORY REPORTS

This Section gives details of the individual NERC/RTP Laboratories (including the Office of the Director) and their programs. In addition to detailing the overall mission and organization of each, this Section provides a summary, highlights major accomplishments, and points up future research emphasis for each Laboratory.

OFFICE OF THE DIRECTOR

The Office of the Director provides overall guidance to, and assumes overall responsibility for, the functions ascribed to the various NERC/RTP Laboratories. In addition to the program coordination activities of its normal staffing, this Office provides a valuable service through its Special Studies Staff.

Special Studies Staff

In addition to performing intermittent short-term studies, the Special Studies Staff is involved in four major research areas: characterization of pollutants, registration of fuels and fuel additives, studies in environmental economics, and coordination of NERC/RTP components in international activities.

Characterization of pollutants consists of collecting, summarizing, and evaluating information concerning the effects of specific air pollutants on human health, animals, and vegetation, and the non-biologic effects such as modification of visibility and weathering of materials. Characterization also includes obtaining qualitative and quantitative information on the sources of pollutants, form(s) of pollutants, reactivity of materials, methods for collecting and quantitating pollutants, and strategies for controlling pollutants.

The fuel and fuel additives registration program, established under authority of the 1967 Clean Air Act, consists of registering information on the chemical composition, purpose in use, and recommended concentration of additives used in motor gasoline introduced into interstate commerce. Quarterly reports are required from fuel manufacturers providing usage data for registered additives. In addition, fuel and additive manufacturers are required to provide information concerning the mechanism of action, effects on exhaust composition, and toxicity of the additive-related exhaust products, if known. The fuel and fuel additives research program is administered under Program Element 1A1002. Current projects include:

- Methodology development to assess the effects of the combustion products of fuels and fuels containing additives on gaseous and particulate emissions, emission control device performance, and atmospheric visibility.
- Characterization of emission products resulting from the combustion of fuels and fuels containing additives, including those emissions resulting from the use of such fuels and fuels containing additives with emission control devices.
- Development of toxicological screening systems to assess the potential adverse effects of combustion products from fuels

and fuels containing additives on public health.

- Development of protocol to assess the effects of fuels and fuels containing additives on public health and welfare.

In the program, "Economic Evaluation of Pollution Effects on Human Health and Welfare," the effects of environmental pollution damage on human health and welfare are analyzed within the framework of economic theory. This is done by translating physical, biological, and welfare damage functions into the language of economics and by developing and testing theoretical constructs and methodologies in which the social costs of environmental pollution can be explained.

The Special Studies Staff coordinates the participation of NERC/RTP and its components in international activities involving:

- The World Health Organization's International Reference Center for Air Pollution Control.
- The Organization for Economic Cooperation and Development.
- Three groups in the North Atlantic Treaty Organization's Committee for the Concern of Modern society – the Modeling Panel, the Atmospheric Assessment Panel, and the Air Quality Criteria Panel.
- The U.S. Special Foreign Currency Program.
- The World Meteorological Organization's global monitoring networks.
- The Economic Commission for Europe.
- Contractual and personal arrangements with foreign firms and governments.

Resources

Resources of the Director's Office, exclusive of those of the NERC/RTP Laboratories, are listed in Table 3.

Table 3. SUMMARY OF RESOURCES FOR OFFICE OF DIRECTOR, NERC/RTP, FOR FISCAL YEARS 1972 and 1973

Category	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
Program management – R&M	341/16	331/15
Pollutant characterization	884/11	805/9
Fuel and fuel additives registration	431/4	280/5
Economic criteria	22/1	44/2
Totals	1,678/32	1,460/31

Figure 15. Obtaining electroencephalogram in carbon monoxide study.

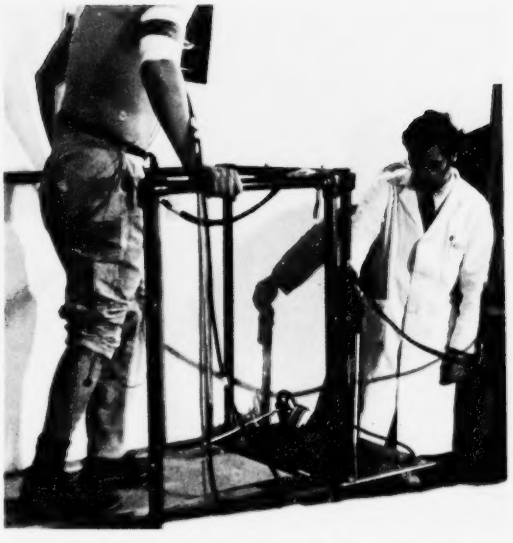

Figure 16. Treadmill exercise to provide data for cardiovascular studies.

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HUMAN STUDIES LABORATORY

Introduction

Mission and General Research Direction

The Human Studies Laboratory (HSL), the former Health Effects Research Division, researches the relationships between environmental pollutants, singly or in combination, and their specific undesirable health effects. This research includes clinical studies on human subjects and epidemiologic studies on human populations. Major emphasis is placed on the collection of sufficient information for formulating environmental controls and thus providing bases for establishing national environmental or emission standards for pollutants or source categories that endanger human health or welfare.

Analysis of the economic value of the health effects is an integral part of the program. The Laboratory also provides staff support to NERC/RTP and the Office of Research and Monitoring. This support includes preparing replies to congressional correspondence, testifying at public hearings or in court, serving on special task forces, and reviewing various documents.

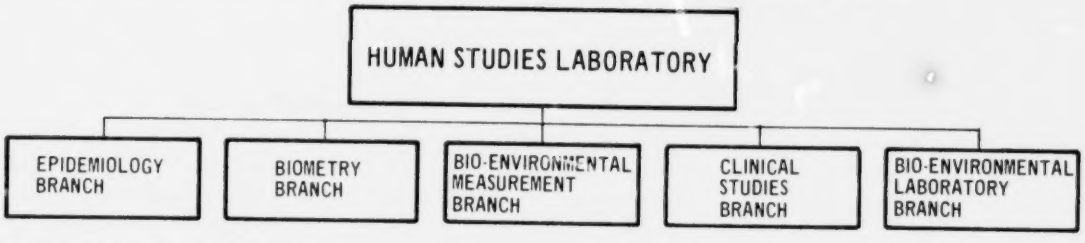
Organization

The HSL is divided into the Office of the Director and five Branches. The Office of the Director coordinates all activities of the Laboratory. From interactions with ORM and NERC/RTP, it develops long- and short-term goals for the Laboratory and serves as a focal point for program planning. The Director provides both for the periodic review of Laboratory programs to assess their progress, and for the rapid and competent response to requests from higher echelons of the Agency.

The Epidemiology Branch conducts studies on man in his natural environment to discern the effects of pollution on physiologic responses and existing disease. The Branch also detects predisposing factors that contribute to the development of various disease states.

The Biometry Branch participates in the design and analysis of research studies within the Laboratory and provides a high degree of competency in the specific areas of statistical design and analysis, computer programming, and data processing. It conducts research in statistical and computer-oriented areas which are related to the aims of the Laboratory.

The Bio-Environmental Measurement Branch conducts a comprehensive program of environmental measurements of synthetically produced and naturally polluted environments. These measurements relate and define the physiological and pathological responses of (1) human subjects to environmental pollutants in bio-medical laboratory research studies and (2) selected population groups in epidemiologic research studies.



The Clinical Studies Branch conducts laboratory studies to detect and define effects of environmental pollutants on human health, verify correlative epidemiological findings, and develop new or improved existing methodology for the application to human health effects studies in the laboratory and community situations. This Branch is composed of several associated smaller laboratory units in which specialized research is conducted.

The Bio-Environmental Laboratory Branch provides the chemical support for the Laboratory. This support includes performing chemical analyses of environmental and biological samples, as well as planning research to determine appropriate methodology for environmental or biological analyses. The Branch also conducts research and development projects related to detection of pollutant-induced changes in human populations.

Table 4. SUMMARY OF RESOURCES FOR HUMAN STUDIES LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 and 1973

Category	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
Community health effects surveillance studies	2,038/43	6,505/80
Biomedical research	2,992/66	1,398/17
Radiation epidemiological research		320/9
Totals	5,030/109	8,223/106

Physical Facilities

The Human Studies Laboratory has facilities both in the Research Triangle Park and in Chapel Hill, North Carolina. Much of the research conducted by this Laboratory is done in cooperation with the University of North Carolina at Chapel Hill. Laboratories in both locations are equipped with the most modern analytical instruments; these include gas/liquid chromatographs, atomic absorption spectrometer with a heated graphite atomizer, ultra-centrifuges, disc gel and slab electrophoresis, radioactive strip-scanning devices, and liquid scintillation spectrometers.

In October 1972 the administrative offices and central laboratories of the Clinical Research Branch were relocated in the Clinical Environmental Research Laboratories building on the periphery of the UNC Medical Center complex in Chapel Hill. This is a special-purpose building complete with a high-bay area constructed specifically to assist in fulfilling EPA medical research objectives and to provide special-purpose laboratories and support areas. These special-purpose laboratories include:

- Controlled environment laboratories.
- Cardiovascular research laboratory with facilities for perfecting and validating non-invasive cardiovascular physiology measurement techniques and for processing cardiovascular data from animal studies.
- Experimental surgery and acute animal-exposure rooms with independent ventilation, impervious walls and ceiling, floor drain, and four animal-exposure chambers.
- Psychophysiology laboratory for human behavioral and psychophysiologic studies.
- Pulmonary physiology laboratory for developing and validating new techniques for pulmonary function measurement.
- Clinical metabolism laboratory for performing routine and specialized human and animal clinical chemistry analyses.
- Several peripheral laboratories including the research pulmonary laboratory at the Frank Porter Graham Child Development Center in Chapel Hill, the exercise physiology laboratory, and the pathology laboratories.

Major Program Areas

Summary of Present Programs

The HSL conducts activities in two major program areas: field epidemiological studies in ambient pollution exposure situations and

laboratory studies in animals and human subjects under experimentally produced exposure conditions. The field epidemiologic investigations are identified by the acronym CHESS. (See the Special Features article on CHESS elsewhere in this Report.) Studies that are currently in progress in 33 communities provide gradients of exposure to total suspended particulates, respirable suspended particulates, sulfur dioxide, nitrogen dioxide, and photochemical oxidants.

Laboratory studies include investigation of acute and chronic toxicity of specific materials in cultured cell systems, in animal models, and, when possible, in human subjects. Other areas of study include interactions of multiple pollutants, effect of pollutants on defense mechanisms against biologic pathogens, and the relationship of pollution exposure to the development of carcinogenic, mutagenic, or teratogenic processes.

Human clinical studies include investigation of the acute effects of short exposure to levels of CO sufficient to produce 5 to 10 percent COH in blood and of the effects of chronic exposure for period of several weeks to monitor low levels of specific heavy metals. To date, the chronic-exposure studies have been limited to lead and manganese.

Major Accomplishments

Major field study accomplishments during FY 1972 involved mainly the CHESS program. CHESS was greatly expanded during FY 1972 to include 33 neighborhoods in six areas of the country. Studies completed in the 1970-1971 school year were analyzed and reported in the EPA monograph, **Health Consequences of Sulfur Oxides: A Report from the CHESS Program, 1970-1971**. These studies revealed the entirely new finding that adverse human health effects are consistently associated with exposure to suspended sulfates, more so than to sulfur dioxide or total suspended particulate matter. The results are highly significant in that suspended sulfates are dispersed far more widely throughout the northeast and at greater distances from urban emission sources than is gaseous sulfur dioxide.

CHESS studies demonstrated the benefits of improved air quality on chronic respiratory disease as experienced by subjects who moved out of New York City to low- exposure communities. Furthermore, recent improvements in air quality in New York appeared to benefit the lung function of younger children. Similarly, children living in polluted communities for 3 or more years were found to have more acute respiratory disease episodes than recent immigrants to that community, suggesting that improved air quality would prevent this adverse response.

In the area of laboratory studies, data crucial to the support of existing short-term carbon monoxide standards were obtained through in-house studies. Controlled human exposures to 50 ppm carbon monoxide for 4 hours caused significant electrocardiographic disturbances in exercising adults 40 years of age and older who had no previous evidence of heart disease. Furthermore, these low-level exposures shortened the time interval required to produce chest pain in exercising subjects who were known to experience chest pain upon exertion. Thus, low-level carbon monoxide exposure was shown to enhance the pre-clinical and clinical signs of arteriosclerotic heart disease in moderately stressed subjects.

Future Research Emphasis

The CHESS program will place strong emphasis on consistent relationships in communities over space and time. Resulting data will provide sound quantitative information to assess health costs of exposure and benefits of control for the major urban air pollutants. Timely reporting of CHESS results will be

emphasized, enabling the Agency to evaluate the impact of existing standards, the need for revising standards, and the desirability of taking new control actions.

The Laboratory will assemble a national tissue bank to derive new health data on trace metals, synthetic organic compounds, and other multimedia toxic substances. Personal monitors of human exposure and physiologic effects can be developed to quantitate human dose-response relationships under changing indoor and outdoor circumstances. Also, with completion of the human-exposure facility in Chapel Hill early in FY 1974, rapid-response studies of human exposure to gaseous pollutants, noise, and non-ionizing electromagnetic radiation can be conducted to support Agency needs.

Other major efforts during FY 1973 will be directed toward:

- Publication of a summary on the effects of CO exposure on behavior and physiology that can be used to support the primary ambient air quality standards.
- Completion of a Clinical Laboratory Evaluation and Assessment of Noxious Substances (CLEANS) program to determine behavioral and physiologic effects of acute exposure to controlled levels of pollution.
- Establishment of a dose-response curve relating to the development of thyroid tumors in children exposed to diagnostic doses of radioactive iodine.
- Publication of the monographs **Health Consequences of SO_2 Air Pollution** and **Health Consequences of Respirable Particulate Air Pollution.**

Figure 17. Doctors confer on data obtained in cardiovascular studies.

Figure 18. Inverted microscope utilized in bacteriology studies.

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EXPERIMENTAL BIOLOGY LABORATORY

Introduction

Mission and General Research Direction

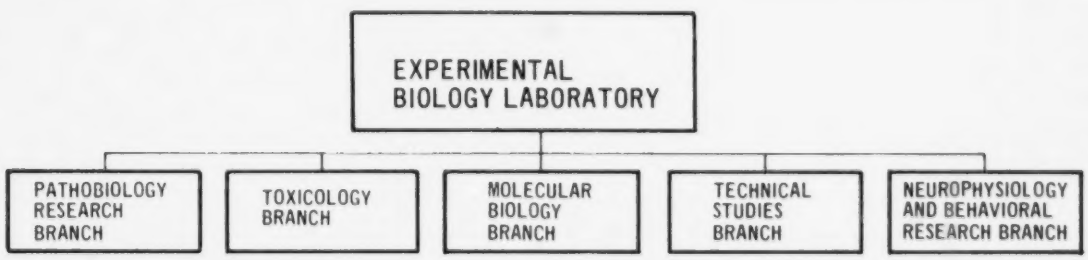
The predecessor of the Experimental Biology Laboratory (EBL), the former Twinbrook Radiation Laboratory, came into being with the formation of EPA through the binary division of the Division of Biological Effects, Bureau of Radiological Health, DHEW. The mission of the Laboratory has been to conduct an intra- and extramural research program to study the extent and effects of ionizing and non-ionizing radiation in the environment. Results of the epidemiologic studies and animal investigations supported by the Laboratory have been aimed at defining environmental radiation health hazards and providing data on which to base criteria used in developing radiation exposure standards. As EBL, the Laboratory conducts and manages biological research designed to detect, define, and quantify the effects of environmental pollution.

Organization

EBL consists of the Office of the Director and five Branches. The Director provides direction to the Laboratory's studies and research designed to evaluate the effects of environmental pollutants in terms of specific and undesirable effects. He also ensures that the major emphasis of the Laboratory research is placed on developing information for formulating and revising environmental quality criteria in support of human health studies.

The Pathobiology Research Branch was formed in FY 1973 from the personnel and ACTION program of the Cellular Biology Section, Biomedical Research Branch, Human Studies Laboratory. It conducts intramural, contract, and grant investigations of the effects of environmental pollutants upon cellular and organ system models of human disease. These models include both risk factors for chronic disorders and models of specific acute or chronic diseases. Included are **in vivo** and **in vitro** models for infectious, neoplastic, and other non-infectious conditions. The morphologic and functional integrity of cellular and organ systems is used to elucidate effects of environmental pollutants.

The Toxicology Branch investigates the acute and chronic effects of low-level exposure of whole animals to environmental pollutants; these studies quantify the absorption, distribution, storage, mobilization, biotransformation, and excretion of environmental pollutants and the biological effects of pollutants in selected species. The effects



selected relate to risk factors for acute illness, chronic disease, and reproduction.

The Molecular Biology Branch investigates the biological, chemical, and physical effects upon cellular, subcellular, and macromolecular systems, with particular reference to biogenetic effects. Special emphasis is placed on utilization and development of **in vitro** screening systems that may be used to evaluate mutagenic, carcinogenic, and overall potential toxicity of various environmental agents.

The Technical Studies Branch provides technical support to other branches within the Experimental Biology Laboratory and conducts special studies involving dosimetry, instrument development, and analytical methods. Areas of support include biometry, data processing, computer programming, bioenvironmental engineering, and monitoring.

The Neurophysiology and Behavioral Research Branch investigates the acute and chronic effects of low-level pollutants, particularly microwave radiation and exposure of animals to noise. Techniques of neurophysiology offer an excellent tool to examine subtle effects from low-level exposure.

Table 5. SUMMARY OF RESOURCES FOR EXPERIMENTAL BIOLOGY LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
Radiation epidemiological research	479 12	
Radiation health effects research	1,522 41	1,033 32
Radiation methods and measurements	222 10	154 7
Biomedical research	—	1,067 11
Totals	2,223 63	2,254 50

Physical Facilities

The Experimental Biology Laboratory's microwave exposure facility, located at NERC/RTP, is unique. The microwave source is a fixed-frequency, commercial-band (2450 MHz) magnetron, operating continuous-wave with a variable power output ranging from zero to 3000 watts. The transmitting horn antenna is in a shielded anechoic chamber that is absorber-lined to provide a simulated free-space environment, essentially free of complex electromagnetic wave reflections. The microwave generator produces precisely known and reproducible exposure conditions for the various bioeffects studies. The range of exposure power densities used is from 10 $\mu W/cm^2$ to 400 mW/cm^2.

The immediate environment of the irradiated animal is regulated with respect to temperature, relative humidity, wind velocity, and atmospheric gas concentrations. The microwave generator and the environmental control system are both designed for computer operation. The control facility uses a Xerox CF-16 minicomputer for both experiment control and data acquisition. The central processing unit has 16,000 words of central core, with a fixed-head disc memory providing the base for the operating system. A single, 9-track, 800-BPI, magnetic tape transport, also interfaced to the system, is used for source program development and for data storage from the various experiments. The system also has analog and digital interfaces for controlling the various items of ancillary instrumentation.

Major Program Areas

Summary of Present Programs

The laboratory is currently investigating the biological effects of tritium and krypton, the major environmental radioactive contaminants from nuclear reactor and fuel-reprocessing plant operations. Present efforts are designed to determine the dose-effect relationship between intra-uterine exposure to tritiated water (HTO) and subsequent tumor production and non-specific life-span shorten-

ing. In addition, the effects on the F_2 generation of lifetime parental exposure to HTO in terms of pre- and post-implantation mortality, abnormalities, and gross physical characteristics of the offspring are being studied. Because the present MPC for 85Kr exposure is based on solely theoretical dose calculations, studies involving the inhalation or total body exposure of guinea pigs are being conducted to evaluate the standard.

The Laboratory is also currently investigating the radioactive effects of tritium, of which cancer is a major consequence. Present experiments are designed to investigate the tumorigenic effects in rats of continuous exposure to tritium in the form of tritiated water.

A study of environmental stress is being conducted using metabolically active proteins and naked DNA to assess environmental mutagens of both a chemical and a physical nature, including electromagnetic radiation. Characteristics examined include absorption spectrum changes, fluorescence profiles, hydrodynamic measurements, DNA damage convertible to backbone scissions, biological lethality, and mutation frequency. Environmental stresses are also being examined through the study of several mammalian cell/animal systems, including mouse and human fibroblasts and mouse lymphoma cells. Endpoints include lethality, mutagenicity, viral resistance, repair of DNA injury, and other biochemical parameters. These systems can also be used to determine the possible health effects of various aromatic fuel additives and pesticides.

In-house and contracted tasks of the Laboratory's new ACTION program include the following: effects of air pollutants on pulmonary defense mechanism, cellular physiology and metabolism techniques for cytotoxicology, and physiologic and pathologic studies of pulmonary response to hydrocarbon air pollutants in Syrian golden hamsters.

Major Accomplishments

In the area of effects from chronic exposure to ionizing radiation, a contract was initiated with the University of Colorado to assess the risk of cytogenetic changes in cord blood of children in Mesa County, Colorado, whose parents were exposed to uranium mill tailings used in construction. A model was developed from the available indoor radon and gamma measurements to estimate how many houses with elevated indoor radon would be cleaned up at various gamma levels. Predictions from this model were used in making recommendations to the Atomic Energy Commission for action in Mesa County under the joint Federal and state cleanup program.

Major accomplishments in the area of electromagnetic effects include studies on the effects of non-ionizing radiation on protein systems and on mammalian cell function and response to stress. Characterization of the protein, bovine serum albumin (BSA) by ultraviolet solvent perturbation difference spectroscopy was completed, with the addition of data derived from studies of charcoal-defatted BSA. This information will be used to determine whether the state of macromolecular flexibility is an important factor in the interactions between non-ionizing radiation and macromolecular systems. The preliminary results to date of the study of a mammalian cell culture system, in which autoradiography was utilized to examine the percentage of cells in S-phase at various times after receiving a UV dose, indicate a positive correlation between radiation exposure and cell DNA synthesis. Although thorough statistical analysis has not yet been completed, at 3 days a significantly higher percentage of S-phase cells is seen in the irradiated cell cultures than in the control group. This result has not yet been explained, but may reflect the regrowth of cells to replace cells lethally damaged by the UV radiation.

Future Research Emphasis

Future development and growth are intended to endow this Laboratory with the capability to conduct research on the biological effects of a wide variety of noxious agents – biological, chemical, and physical.

Expanding on developments produced in current programs, emphasis has been placed on the effects of tritium on mammalian systems in order to determine the efficacy of present radiation protection standards. At best, environmental standards are based on biological data on the effects of a particular pollutant as a single stress. In reality, the organism or system is under multiple stresses. Standards should be re-evaluated in light of experiments employing potentially synergistic stressors. Tritiated water is ideal as a matrix upon which other meaningful waterborne pollutants may be superimposed; e.g., since both HTO and lead are present in most community water supplies, and since both have effects on the central nervous system, the co-stress observation could then be evaluated for their influence on the individual standards for HTO and lead.

Similarly, work on mammalian cell culture systems is in preparation for evaluating the toxicity of various environmental agents. These systems will provide information regarding effects at the cellular, subcellular (membranes; organelles), and molecular levels of organizations. They will serve as a basis for establishing a screening system based upon utilization of physiological parameters. These systems are fundamental to all known mammalian cells. Such an approach is of importance in evaluating molecular pathology and indicators of potential toxicity in whole animals, including man.

A variety of mammalian cell systems and growth conditions will be employed to randomize the experimental design, determine dose-response (cellular pharmacodynamics), evaluate mutagenic and carcinogenic defects, and elucidate molecular mode of action of various toxic agents. Mitotically synchonized cell cultures will be used to evaluate cell-cycle sensitivity of the system to low levels of various environmental agents. These cell systems will be used to determine genotypic effects (structural integrity of DNA, activity of repair systems, chromosome aberrations) and alterations in phenotype (RNA metabolism, protein structure, altered enzyme patterns – synthesis, activity, degradation). These systems will be of immediate use in evaluating the potential toxicity of fuel additives. They also serve as a preliminary toxicology screening system for evaluating the biological activity of other toxic chemical substances and physical stress such as electromagnetic radiation.

EBL, along with the Human Studies Laboratory and the Chemistry and Physics Laboratory, has developed research plans to assist EPA in effecting requirements of the Noise Act of 1972. Efforts have been made by EBL to recurit suitable expertise in noise effects and to continue its efforts in establishing a responsive noise research program in cooperation with OR & M and EPA's Office of Noise Abatement and Control.

Figure 19. Control console with associated monitoring equipment for environmental exposure chamber.

Figure 20. Squirrel monkey used in pesticide effects studies at Perrine, Florida.

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PRIMATE AND PESTICIDES EFFECTS LABORATORY

Introduction

Mission and General Research Direction

The primary objective of the Primate and Pesticides Effects Laboratory (PPEL), known formerly as the Perrine Primate Laboratory, is to assess the human health effects of pesticide exposure. Research is conducted to determine the effect of pesticides and their metabolites on normal biological functions, with special emphasis on the primate nervous system. These studies are concerned not only with single pesticide exposure, but also with combinations of pesticides and pesticides in conjunction with other environmental factors. This research provides the data from which environmental standards can be proposed for pesticide control. The Laboratory is also responsible for continuing development and evaluation of techniques and chemical methods for direct and indirect measurement of exposure to pesticides.

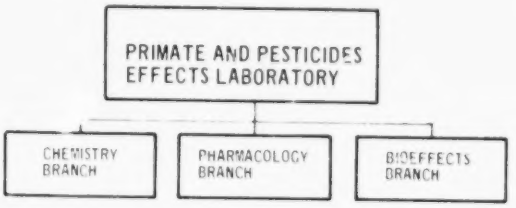
Some of the immediate research objectives of the Laboratory include:

- Development of new analytical methods for pesticides.
- Evaluation of existing methodology by quality control and collaborative studies.
- Investigation of the toxicity of economic poisons.
- Determination of the extent of human exposure to pesticides under industrial and field applications.

Organization

The PPEL is divided into the Office of the Director and three Branches: The Chemistry Branch, the Pharmacology Branch (including the Wenatchee Research Section in Washington State), and the Bioeffects Branch (in Chamblee, Georgia).

The Chemistry Branch develops and evaluates analytical methods for the accurate identification and measurement of microquantities of pesticides. The Branch maintains quality control of analytical work and methods for laboratories working under contract with EPA's Pesticides Program. The quality control program also assists the Laboratory chemists in evaluating the needs of the field laboratories and in improving techniques and methods of pesticide analysis.



The primary research mission of the Pharmacology Branch is to examine nonhuman primates for changes in physiological, biochemical, and metabolic responses due to long-term low-level exposure to pesticides. The major considerations of the Branch include the study of neurophysiological and neuroendocrine effects, metabolic interactions of pesticides with other pesticides, and teratologic effects of pesticides and their metabolites.

The Pharmacology Branch's Wenatchee Research Section researches the exposure of the general population as well as of persons occupationally and environmentally exposed to pesticides, and evaluates the possible health effects of these exposures. It develops and evaluates new or improved techniques and

chemical methods for measuring pesticide exposure. The Section also conducts tests under field conditions to determine improved methods for safe disposal of limited quantities of waste pesticides, decontamination and disposal of empty containers, and cleanup of surfaces contaminated by pesticide spillage during transportation and storage in order to prevent contamination of persons or foodstuffs.

The Bioeffects Branch, formerly called the Chamblee Toxicology Laboratory, is a center for the study of the effects of pesticides on human health associated with the safety and effectiveness in their use as economic poisons. The research program develops new data on the toxicity of new and old pesticides and determines their modes of actions and their effects on physiological body functions. Emphasis is on short-term studies, including LD_{50} values, and on use of small laboratory animals. Other activities of the Branch include consultation with and analytical assistance directly to State health departments, hospitals, and physicians on pesticide poisonings.

Physical Facilities

The research conducted by the Laboratory takes place in three geographic locations: the largest facility is in Perrine, Florida, and two smaller units are in Chamblee, Georgia, and Wenatchee, Washington. These three laboratories are equipped with the most modern biomedical and analytical equipment available, including gas chromatographs, pH stats, atomic absorption instruments, infrared spectrophotometers, pH meters, integrators, recorders, and mass spectrophotometers. The Laboratory maintains the capability to keep these delicate instruments continuously operable.

The Laboratory also is equipped with all common laboratory experimental animals, including the Squirrel and Rhesus monkey, all cared for by trained laboratory personnel.

Table 6. SUMMARY OF RESOURCES FOR PRIMATE AND PESTICIDES EFFECTS LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000) Positions	FY 1973 ($000) Positions
Pesticides health effects research	2 087 63	1 947 63
Pesticides identification methodology	232 11	204 11
Monitoring quality assurance	217 11	257 11
Program support	80 0	250 0
Totals	2 616 85	2 658 85

Major Program Areas

Summary of Present Programs

A major program of the Primate and Pesticides Effects Laboratory is the development of various high-level instrumental techniques. Specific major areas of current research and analytical service emphasis within these goals include programs in magnetic resonance, trace metal analysis, and mass spectrometric instrumentation. Emphasis in magnetic resonance is placed on the interaction of pesticides and their metabolic products with a variety of biological substrates and other appropriate model systems by using NMR methods

Project emphasis in the area of trace-metal analysis includes the development of an analytical scheme using atomic absorption spectrophotometry and gas chromatography to determine the normal heavy-metal concentration levels in human and animal tissues. Such specific detection systems as flame photometry are used to measure increased levels of concentration resulting from acute and chronic exposure to pesticides.

The mass spectrometric instrumentation project develops mass spectrometry and gas

chromatography techniques to identify isolated pesticide residues and metabolites. A major activity of this project is the evaluation of combined GC-MS techniques.

Analytical evaluation of testing methods is still another major concern of the Laboratory. In the analysis of human and environmental samples, testing methods must be reliable to ensure accurate quality control. To achieve this goal, the Laboratory maintains contacts with 19 laboratories throughout the country which currently comprise the Community Pesticide Studies and National Monitoring network. This program of intra- and inter-laboratory analytical quality control is of vital importance in the assurance of reliable analytical data. The Primate and Pesticides Effects Laboratory assists these laboratories by testing the sampling and analytical procedures used by the contract laboratories, numerous regional laboratories, the recently organized National Center for Toxicological Research (NCTR) laboratory, and additional State pesticide projects.

The Pharmacology Branch's major program area provides necessary toxicological information on the health effects of repeated acute and long-term, low-level exposure to pesticides and related environmental contaminants. Current tasks encompass subacute toxicity testing, teratology, development and reproduction, pathology, biochemistry and metabolism, and neurophysiology and behavior in rodents and primates. Emphasis is on primate studies. Effects data from these animal studies will be related to human situations to ensure the recognition of sensitive indicators of subtle but hazardous effects.

The major program area of the Bioeffects Branch is testing toxic substances, specifically pesticides and related compounds, for adverse effects in experimental animals and humans. This research can be used by EPA to estimate and predict the effects of individual exposure to a specific compound and to establish adequate environmental standards for that compound.

Major Accomplishments

The Chemistry Branch has several major accomplishments to its credit. These include: development of gas chromatography columns most useful for monitoring pesticides in human and environmental media; development of specifications for selecting batches of Florisil, an adsorbent used widely in pesticide residue analysis; development of a series of methods for determining man's exposure to a broad spectrum of biodegradable pesticides; development of new methods for determining trace metals in human tissue and excreta, using both gas chromatography and selective volatilization techniques in atomic absorption spectrophotometry; and identification of many pesticides in human adipose tissue, utilizing gas chromatography-mass spectrometry techniques.

Major accomplishments of the Pharmacology Branch were achieved in three separate program areas:

Teratology – The Branch helped establish the teratology program of the National Center for Toxicological Research (NCTR); established the teratogenic action of pentachloronitrobenzene (PCNB) in the C57 B1/6 mouse; and initiated a program concerned with the distribution of heavy metals in fetal and maternal tissues associated with teratogenicity.

Biochemistry and Metabolism – The Branch isolated and identified urinary metabolites (five of them previously unreported) from lindane-treated rats.

Neurophysiology – The Branch produced the characteristic hexachlorophene-induced brain lesion in Squirrel monkeys, correlated it with a deficit in

visual-evoked response (VER), and showed that exposure levels below those producing lesions also resulted in VER deficit. Another Branch finding was supportive of a central nervous system action of carbaryl affecting endocrine balance. Using a Squirrel monkey, the Branch developed a primate model for organophosphate-induced demyelination.

The Bioeffects Branch played an important role in defining the level of DDT and DDE in fatty tissue of the general population and of various environmental and occupational groups. Followup studies at this and other laboratories indicated that there has not appeared to be an increase in the trend of storage in fatty tissue of the general population of this country since the earliest survey in 1950. Also, Branch studies were the first to show that organophosphorus compounds such as parathion and azinphosmethyl may persist in the soil at relatively high levels for several years, especailly where highly concentrated formulations are involved. Such spillages have resulted in poisoning of small children who came in contact with the contaminated soil. This discovery emphasized the importance of recommending that soil contaminated by spillage of a highly toxic pesticide be collected and buried.

Future Research Emphasis

The Laboratory will continue work on physiological and biochemical effects on experimental animals, further development of more accurate testing methods and devices, and the expansion of the quality control program.

In the physiology area, personnel will be working specifically with the quantitative analyses of EEG patterns taken from monkeys and squirrels to differentiate between classes of pesticide agents. Work will also be performed with electrical activity recordings of the isolated, perfused, whole brain to determine time-course of electrical changes. Such studies will also include other nerve centers.

In the area of biochemistry and metabolism, work will be directed toward determining the effect of pesticides on certain internal organs and chemical processes of the body. Much of this work will be in the rat and then expanded to the monkey. Effects of enzymes on the toxicity of pesticides, the effect of pesticides on the stimulation of enzyme activity, the effect of pesticides on the thyroid and secretion of thyroxine, and the effects of DDT and lindane on metabolism are integral parts of the future work of the Laboratory.

One of the high-priority objectives in the analytical evaluation area is the construction and testing of a device to collect large-volume air samples for pesticide monitoring. Studies involving the establishment of sensitivity limits and evaluation of methods to improve sensitivity of both gas chromatographic and atomic absorption techniques will be undertaken.

Multiresidue methods for determining the extent of human and animal exposure to persistent and biodegradable pesticides will continue to be developed. Pesticides and their metabolites to be investigated include chlorinated hydrocarbons, organophosphorus compounds, carbamates, fungicides, and herbicides.

Much of the research performed at Perrine is used to provide a data base from which pesticides standards can be implemented. Thus, a continuing effort of the Laboratory is the management of a program for intra- and interlaboratory quality control. Six more Community Studies Laboratories are scheduled to be added in the near future. This will increase the participation in the formal Quality Control Program to 36 laboratories. It is anticipated that newly organized State and

EPA laboratories will be provided all assistance possible on an informal basis. Completion of a portable EEG will permit acquisition on tape of EEG recordings from occupationally exposed pesticide workers. Installation of a closed-circuit television system will permit initiation of primate behavior studies.

Figure 21. Electron microscope used in pesticide analysis studies in Chamblee, Georgia.

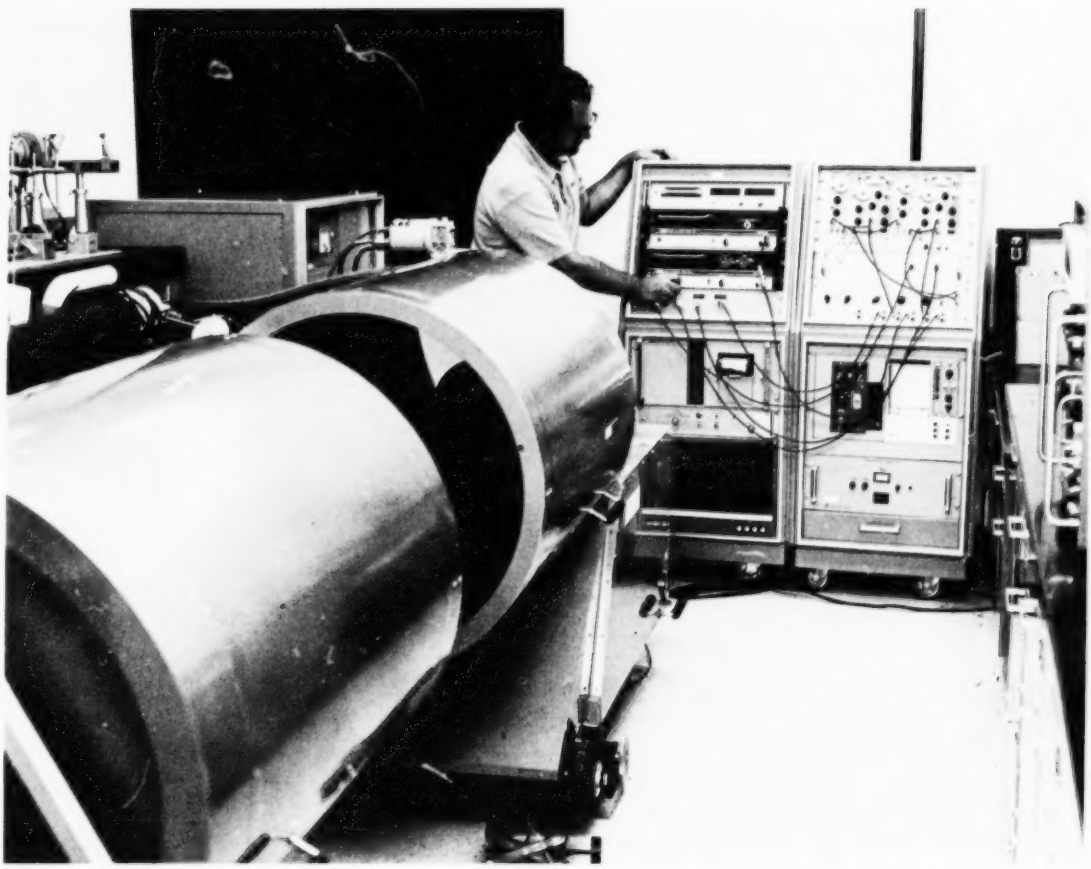


Figure 22. Field prototype infrared spectrophotometer for long-path and remote detection of pollutants.

CHEMISTRY AND PHYSICS LABORATORY

Introduction

Mission and General Research Direction

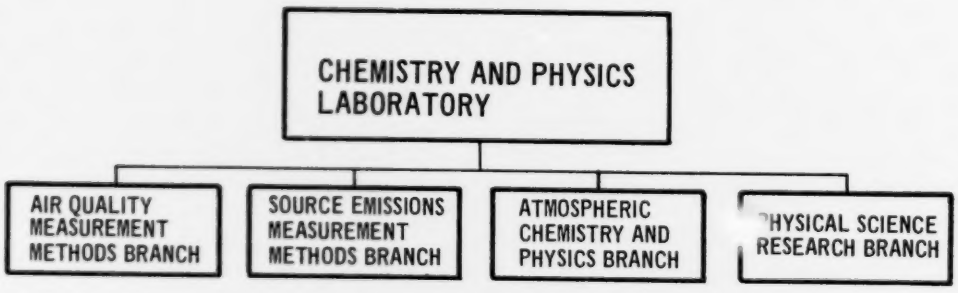
The Chemistry and Physics Laboratory carries out research in two main areas: developing techniques and instruments for the measurement of pollutants, and developing information on atmospheric chemistry and physics. The measurement techniques and instrumentation program includes the development of manual and instrumental techniques for measuring pollutants in ambient air and in source emissions. The program is highly oriented toward appropriate measurement methods for determining compliance with those air pollution standards and regulations already promulgated and those planned for the future. The atmospheric chemistry and physics program involves laboratory and field studies. Hypotheses developed in the laboratory studies are tested in the field by analysis of the atmosphere at critical sites. These data are used to choose appropriate air pollution control strategies and to develop mathematical models of atmospheric photochemical reactions.

Organization

CPL consists of four Branches reporting directly to the Office of the Director. This Office manages the Laboratory's research programs which are directed toward the development of instruments and measurement techniques, toward the development of experimental and theoretical studies of both the ambient atmosphere and of plumes, toward the determination of the physical effects of emissions associated with the use of fuels and fuel additives, toward effects research of air pollutants on materials, and toward the development of techniques for analyzing samples containing radioactive materials.

The Air Quality Measurement Methods Branch develops and evaluates new and improved instruments and measurement techniques for use in the ambient air. The Branch refers new instruments and techniques to the Office of Measurement Standardization and publishes the results of its work to inform private industry of the developments.

The Source Emissions Measurement Methods Branch develops and evaluates instruments and measurement techniques for pollutants in both mobile and stationary


CHEMISTRY AND PHYSICS LABORATORY
AIR QUALITY MEASUREMENT METHODS BRANCH
SOURCE EMISSIONS MEASUREMENT METHODS BRANCH
ATMOSPHERIC CHEMISTRY AND PHYSICS BRANCH
PHYSICAL SCIENCE RESEARCH BRANCH

source emissions. Both this Branch and the previously mentioned one refer new instruments and techniques to the Office of Measurement Standardization. This Branch also publishes its results to assist in the commercialization of the needed instrumentation and equipment.

The Atmospheric Chemistry and Physics Branch conducts a comprehensive research program related to the formation and decay of air pollutants in the atmosphere and the impact of mobile and stationary source emissions on atmospheric chemistry. The Branch also participates in the development of atmospheric models for chemically reactive atmospheric systems.

The Physical Sciences Research Branch conducts research and development projects requiring radio-analytical and stable-element determinations, develops radiochemistry measurement techniques, and conducts research to determine and evaluate the effects of environmental pollutants on materials.

Table 7. SUMMARY OF RESOURCES FOR CHEMISTRY AND PHYSICS LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
Instrumentation and analytical methods development	5,140 59	4,338 59
Formation and decay of pollutants	3,049 20	2,500 17
Fuel and fuel additives registration	324 1	601 2
Regional Air Pollution Study (RAPS)		1,390 5
Standardization of instrumentation and analytical methods	1,358 9	
Totals	9,871 89	8,829 83

Physical Facilities

The physical facilities of CPL consist of conventional laboratory equipment, as well as items of an unusual or unique nature, located both in NERC/RTP laboratories and in mobile laboratories that permit their use in field situations. Among the Laboratory's unusual items of equipment are:

- A prototype research lidar system, designed specifically for measuring particulates from stationary sources (housed in a van).
- Two prototype research infrared spectrophotometers for remote emission sensing from stationary sources.
- An experimental stationary source simulator (to be installed in a leased facility at Beaunit Corporation's RTP plant).
- A mobile source emissions laboratory equipped with an Hitachi RMU-6L mass spectrometer coupled to a Perkin-Elmer 990 gas chromatograph, NMR, Varian T60, infrared spectrophotometer (P-E 180), and ultraviolet-visible spectrophotometers (Cary Model 14 and Beckman Model B).
- A mobile source testing facility that includes a water brake certification dynamometer, complete with the original constant-volume sampler and a particulate sampling tunnel.
- Several mobile laboratories equipped with gas chromatographs, ozone, SO_2, and NO_x analyzers, aerosol sampling and sizing equipment, and meteorological weather monitoring equipment.

Major Program Areas

This Laboratory's efforts fit primarily into three areas: development of techniques and instrumentation for measurement of air quality and pollutants in emissions from both stationary and mobile sources; and studies of the formation and decay of pollutants in the atmosphere.

Summary of Present Programs

Research in the area of measurement techniques and instrumentation development

provides methods for the extraction and analysis of contaminants from both the environment and from source emissions. It includes the development of measurement methods and instruments for gaseous pollutants, particulate matter, and designated hazardous pollutants. Pollutants of interest are sulfur compounds, nitrogen oxides (NO_x), photochemical oxidants, CO, hydrocarbons, particulate matter, mercury, beryllium, asbestos, and odiferous materials.

Improved instruments for measurement in air of SO_2, NO_x, and photochemical oxidants have been developed. Improved instruments for measuring CO, hydrocarbons, and other pollutants will soon be available.

The program area concerned with measurement methods for mobile sources consists of studies to identify pollutants emitted from mobile sources, to develop measurement methods and instruments for compliance testing and certification of vehicles, and to establish procedures for determining effects resulting from the use of fuels and fuel additives. The overall program is aimed at all mobile sources, including automobiles, diesels, turbines, and, ultimately, ships, trains, and household machinery such as lawnmowers.

Current efforts are aimed at developing real-time analytical techniques for CO emissions from vehicles that meet the 1975 and later emission standards, real-time measurements of specific hydrocarbons with particular emphasis on those related to reactivity problems such as methane, ethane, and ethylene, measurement techniques for oxygenated hydrocarbons, and the analysis of unusual emissions from prototype vehicles using novel control systems.

Another major program area of CPL is the study of the formation and decay of pollutants. This area includes several specialized studies, one of which focuses on the removal of toxic and noxious substances in the atmosphere. Here, the transformation within classes of pollutants such as the nitrogen compounds and organic compounds are studied, and the interactions among the various compounds are defined. Other studies within this area include researching the atmospheric chemistry of gaseous pollutants and the dynamics and chemisorption of particulates in ambient air. Research here is oriented toward obtaining information on reaction mechanisms and kinetics to be used in the development of atmospheric models.

Major Accomplishments

During the period of this report, the Chemistry and Physics Laboratory has compiled a significant list of major accomplishments in the three major program areas. Among others, outstanding accomplishments include:

- Worldwide acceptance and commercialization of an ozone-measuring instrument operating on the principle of chemiluminescence arising from the ozone-ethylene reaction.
- The development and early commercialization of an instrument that measures nitric oxide and nitrogen dioxide.
- Assembly and demonstration of a first-generation prototype instrument, adaptable to a number of chemiluminescent analytical techniques, that offers important cost-reduction potential for monitoring instrumentation.
- Determination of the precise optical requirements and capability of the in-stack transmissometer for monitoring the opacity of emissions from coal-fired power plants and other stationary sources, and the delineation of performance and installation specifications for such monitors.
- Invention, development, and field-testing of a highly successful source sample dilution system that facilitates the coupling of gas analyzers to source effluents for precise measurement of emissions.

- Design and fabrication of the first successful ozone-chemiluminescence detector for measurement of NO_x in auto exhausts, its application as the official Federal technique for compliance testing of new vehicles, and its rapid availability as a commercial instrument.
- Completion of an initial field study of the atmosphere in St. Louis as part of the RAPS program. (See the Special Features article on RAPS elsewhere in this Report.)
- An investigation of the hydrocarbon composition in Los Angeles, New York-New Jersey, and Denver in terms of vehicular or non-vehicular emissions. Results indicated that, in some areas, control of auto hydrocarbon emissions alone will not result in the 1975 standard of 250 ppb C being met.

Future Research Emphasis

The Laboratory has several projects planned for FY 73 in the continuing research and development of the chemistry and physics in environmental control, including the development of new and improved instrumental measurement techniques and the development of improved and simplified laboratory measurement methods.

Future research plans will continue to emphasize studies aimed at elucidating the transformation and transport processes of both primary and secondary pollutants in the gaseous, liquid droplet, or particle state. The role of field measurements in delineating atmospheric pollutant interactions will increase. The objective of laboratory experimentation is the development of a photochemical smog model capable of estimating concentrations of ground-level pollutants when incorporated into meteorological models.

The Laboratory will also play a major role in the implementation and direction of the Regional Air Pollution Study.

In addition, the Laboratory plans to install and test a large in-house irradiation chamber. The chamber will be used to study the role of water in photochemical smog, sulfur dioxide removal and oxidation in polluted atmospheres, oxidation of aromatic hydrocarbons, and formation of oxygenates in photochemical reactions.

Figure 23. Scanning electron microscope with X-ray analytical capability.

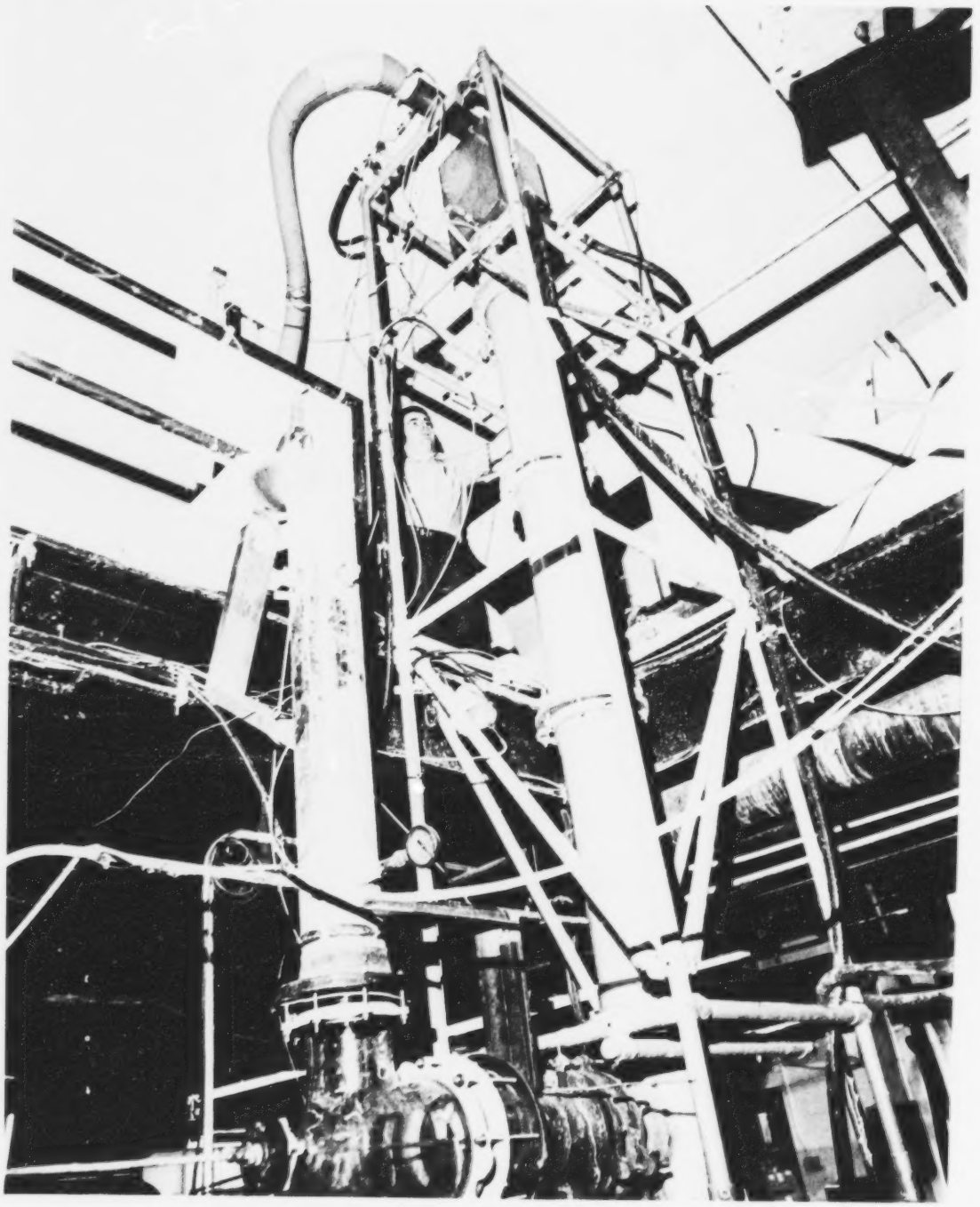


Figure 24. Scale-model simulation of wet limestone scrubbing system at Shawnee power plant.

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CONTROL SYSTEMS LABORATORY

Introduction

The Control Systems Laboratory (CSL) is involved in a variety of technical and management functions directly related to the research, development, and demonstration of equipment and systems designed to abate the emissions of atmospheric pollutants from stationary sources to a level that protects health and welfare, and to do so without creating serious secondary pollution problems.

Mission and General Research Direction

CSL's primary objective has been to ensure the emergence of adequate control technology for pollutants deemed most detrimental to air quality and for which national ambient air quality standards have been (or will be) established. CSL is also assisting in the development of the technology required to permit the achievement of emissions levels selected for performance standards considered necessary to protect public health and welfare. Another important objective of the Laboratory is to develop cost-effective technology in a timely manner.

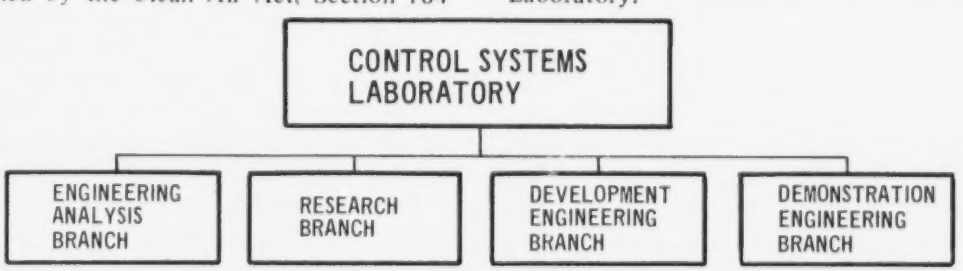
To attack the air pollution problem from stationary sources, CSL has initiated projects along the several avenues of technology specified by the Clean Air Act, Section 104 (a) (1). The Laboratory is pursuing three basic avenues of pollutant control: off-gas cleaning, raw material cleanup, and process and combustion modification.

Although there is a complex interrelationship between pollutants, sources, and technologies, CSL's overall program is categorized into four Program Elements: sulfur oxides, nitrogen oxides, particulates, and hazardous and other pollutants. In each Element, CSL's projects are oriented to serve the needs of particular pollutant sources.

Organization

As indicated by the organization chart, the Control Systems Laboratory consists of four Branches reporting directly to the Office of the Director.

The Engineering Analysis Branch coordinates the preparation of the Laboratory's program-planning documents; maintains a system for controlling total program costs within established budgets; provides broad-based technical analyses and evaluations of CSL's program and proposed projects; develops procedures for assessing the potential impact of the implemented projects; and provides editorial and technical information storage and retrieval services for the Laboratory.



The Research Branch plans and conducts in-house laboratory investigations, field tests, and contract activities directed toward discovering and evaluating new air pollution control processes and equipment, or improving existing ones. As part of its activities, the Branch recommends promising techniques to CSL's Development Engineering Branch for scale-up to pilot plant process studies, researches all conventional fossil fuel combustion processes and modifications to determine the effects of their operating variables on pollutant emissions, provides process measurement services to all Laboratory branches, and provides laboratory support for contract projects managed by CSL.

The Development Engineering Branch is responsible for developing air pollution control processes and equipment which have shown promise during exploratory and applied-research studies and for carrying such development through the pilot plant stage. (Such a system facilitates the solution of problems using facilities designed purposely for problem solving rather than for commercial operation.) The Branch's principal product is quantitative engineering data to permit the most successful processes or equipment to be scaled up to demonstration (or full-size) units.

The Demonstration Engineering Branch is responsible for the full-scale construction and test operation of air pollution control processes and equipment for which technical and economic feasibility has been established through an orderly research and engineering development program. Among the purposes of such projects are problem solving on commercial-scale operations, production of firm engineering data and cost information, and optimizing process performance and economics. The Branch's most important product is certification that processes and equipment are ready for general commercial operation.

The Laboratory's 95-person complement and nearly $30 million funding level for FY 1972 represented a manpower decrease of 17 percent, but a program funding increase of 10 percent over available FY 1971 resources. The difference between the two is the result of allocating a greater portion of the funds to the Laboratory's contract programs.

Within the just-cited budget and with a 12-percent increased FY 1973 budget, CSL has reallocated its resources in keeping with current priorities. The principal difference, a gradual shift of emphasis away from SO_x control as technology develops in that area, is indicated by the dramatic increase in funds allocated to the other three Program Elements: a nearly 350 percent increase for hazardous and other pollutants, over 250 percent more for particulates, and nearly 150 percent more for NO_x.

Table 8. SUMMARY OF RESOURCES FOR CONTROL SYSTEMS LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
SO_x control	21,126/77	18,404/51
NO_x control	1,714/11	3,954/20
Particulate control	750/4	2,723/13
Control of hazardous and other pollutants	436/3	1,930/11
Totals	24,026/95	27,011/95

Physical Facilities

Control Systems Laboratory personnel occupy space in three locations: Research Branch personnel at NERC/RTP; the Equipment Development Section of the Development Engineering Branch in the Mutual Building in Durham; and the remainder of the Laboratory, including the Director's Office, in the Mutual Building Annex, also in Durham.

Research Branch facilities at NERC/RTP include a flue-gas generator, bench-scale

scrubbing equipment, laboratories for odor-problem studies and for the physical characterization of particulates, an electronics shop, and equipment for wet and instrumental analyses. The Branch also maintains and operates a mobile van and trailer equipped with instrumentation for process measurements.

Pilot-size equipment in the NERC/RTP High Bay Area includes a model wet scrubber, a baghouse for fabric filtration studies, and a variety of experimental and commercial combustion systems including furnaces, boilers, and a gas turbine instrumented for most gaseous pollutant emission measurements. (Fuels being investigated are coals, oils, gases, and other liquid and gaseous materials.) An aerodynamic test facility, to be used to test abatement and measurement equipment, is currently being installed.

Major Program Areas

Summary of Present Programs

A major part of CSL's efforts during the past several years has been directed toward solving SO_x abatement problems from power plants. Progress made in that direction is now permitting CSL to devote increasing attention and effort to other important problem areas. Consequently, CSL's work during the past year, while continuing to reflect heavy involvement in the development of SO_x control technology, has advanced on a relatively broad front, with significant progress also evident in non-SO_x areas – progress discernible from the following overview of all Laboratory programs.

SO_x Control. The SO_x control program is directed toward the development and demonstration of control techniques for SO_x emissions from utility and industrial sources. Although the program emphasizes stack gas cleaning systems, with five or six such processes to be demonstrated before 1975, it also includes work in such areas as fuel modification and desulfurization, industrial process modification, and advanced combustion processes.

Milestones were attained in four different SO_x stack gas cleaning programs during 1972: the dry limestone injection test program, started in mid-1970 at TVA's Shawnee Power Plant, was completed; testing on two other programs – limestone wet scrubbing and magnesium oxide scrubbing – was started; and construction of the catalytic oxidation process demonstration was completed. Other projects have also been started – processes that can produce either sulfur or sulfuric acid as a by-product. Analysis of the problem of by-product disposal for regeneration processes indicates that emphasis should be on processes that produce elemental sulfur.

Most of CSL's early coal desulfurization studies were in the area of improving and evaluating physical coal cleaning methods for coal. With the overall potential of physical desulfurization and de-ashing of coal reasonably well established, this approach should have moderate applicability in reducing sulfur by 30 to 70 percent in specific coals. Ongoing work in this area includes washability testing, fine coal desulfurization and cleaning, and pollutant control evaluation and optimization. The most recent research is oriented toward chemical desulfurization of coal and removal of the hazardous pollutants from fossil fuel. New research in chemical desulfurization shows promising results: apparently achieving a 95-plus percent reduction of pyritic sulfur in most coals.

CSL is also engaged in a project aimed at solving both air and solid waste pollution problems: it is co-funding a project for which one goal is characterizing emissions from a municipal waste incineration plant.

Two factors – the major contribution of small coal- and oil-burning sources (area

sources) to the degradation of ambient air quality, and the limited supplies of low-sulfur fuels – indicate a need for clean fuel or coal conversion processes. Accordingly, CSL has provided funds to both the U.S. Bureau of Mines and the Office of Coal Research to assist in both the development of conversion and gasification processes that can provide clean fuels, and the determination of environmental controls that will be required for these techniques.

Of industrial modifications under way, the most advanced is smokeless coke charging, an iron and steel industry demonstration that is currently being placed in operation. Several other projects have been started up relating to Kraft wood pulping, iron foundries, and gasoline bulk loading terminals. Control of coke-pushing emissions, another iron and steel industry demonstration, is also under way. Other projects being considered involve secondary aluminum furnaces, sinter plants, and basic oxygen furnaces in the iron and steel industry.

CSL's research on advanced processes includes a pilot-plant study of molten-iron submerged-coal combustion, and the development of fluidized-bed combustion. Fluidized-bed combustion process options being investigated include pressurized coal combustion; coal gasification for the production of low-sulfur, low-Btu fuel gas; and oil gasification. CSL has also conducted systems studies directed toward the development of advanced power cycles.

NO_x Control. This program involves development of control systems to reduce NO_x emissions, principally from utility and industrial combustion boilers. Bench-scale work and field testing indicate that necessary control for the immediate future can be achieved by modifying combustion processes to reduce NO_x formation. Small-scale evaluation and investigation of promising stack gas cleaning processes are continuing; however, results to date are not too encouraging. Recently under way is a demonstration for reduced-cost, reduced-NO_x emissions from nitric acid plants, using molecular sieve technology.

Particulate Control. The objective of this program is to improve control characteristics and economics of the three principal control methods: electrostatic precipitation, fabric filtration, and wet scrubbing. State-of-the-art studies, completed for each method, also define potential areas of both improvement and new applications. Current research is directed toward enhancing collection efficiency for fine particulates. Also, preliminary evaluation and small-scale research are being conducted on several new and promising concepts for fine-particulates control.

Hazardous and Other Pollutants. This program involves the development of control systems for hazardous and other pollutants, i.e., pollutants other than SO_x, NO_x, and particulates. The program, considering many of the trace elements, includes preliminary evaluation and small-scale development of systems to control odors, incineration products, and hazardous and potentially hazardous pollutants from industry.

A shortage of data currently available is requiring many problem-definition studies in order to deal with these pollutants on a rational basis. Current efforts are pointed primarily toward information gathering; general conclusions include:

- Most hazardous materials are in the form of particulates.
- The quantity of reliable emissions data for hazardous material sources is inadequate.
- Odors can be controlled by incineration processes; however, because of the large volumes of air which must be handled, economics is a limiting factor.

- No satisfactory method exists to describe odoriferous emissions quantitatively.
- Fuel combustion and other high-temperature processes (such as smelting, refining, and waste incineration) are major sources of hazardous pollutants as well as of SO_x, NO_x, and particulates.

Future Research Emphasis

SO_x Control. Several currently active demonstrations of flue gas cleaning processes for controlling SO_x and other pollutant emissions will continue to be supported by CSL. Work directed toward the development of processes for the production of clean fuels will be supported at a somewhat higher level than in the past. Pilot-scale studies of such advanced processes as fluidized-bed combustion will be conducted in FY 73. Although the SO_x control program in the past has primarily emphasized the control of emissions from electric utilities, much of the future efforts will be directed toward the control of emissions from other industrial sources.

NO_x Control. Because combustion is the source of 98 percent of the NO_x from stationary sources, this program will be continued in the direction of developing control technology for combustion applications. Areas that will be investigated, to provide the basis for short-term solutions, include flue gas cleaning processes, catalytic reduction processes, identification and characterization of combustor designs with inherently low NO_x emission levels, and such methods for minimizing NO_x as flue gas recirculation, off-stoichiometric combustion, and excess air.

Longer-range programs include fundamental investigation into the fluid mechanics and chemistry of pollutant formation, as well as advanced combustion design programs.

Particulate Control. Short-term research in particulate control is currently oriented toward improving the performance of, and reducing the operating and capital costs for, three types of collectors: electrostatic precipitators, fabric filters, and scrubbers. Efforts will be expanded to increase the efficiency of these collectors in the particle size range of 2 microns or less. Long-range projects include:

- Development of generalized models for existing collectors.
- Identification and laboratory-scale testing of totally new concepts of particle control technology.
- Pioneering work in small-particle detection and small-particle generation equipment.

Hazardous and Other Pollutants. The hazardous and other pollutants now under specific study are asbestos, beryllium, mercury, fluorides, cadmium, sulfuric acid, aerosols, hydrocarbons, and lead; odorous materials to be considered include those from rendering plants, pulp mills, sewage treatment plants, animal feedlot operations, and chemical process industries. On a wider scale is CSL's process-related interest in identifying the levels and fate of all pollutants.

Planned programs range from determining research and development requirements, through control cost reduction programs, to developing completely new processes for controlling such emissions as those causing odors in the wood pulping industry.

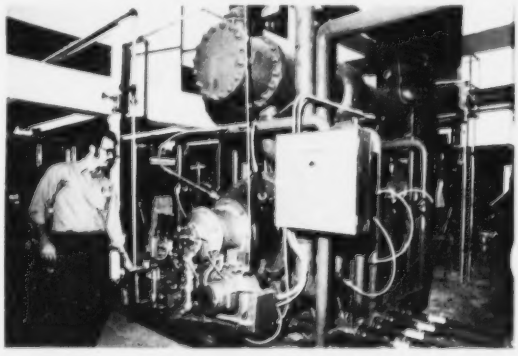


Figure 25. Model furnace that simulates typical commercial boilers.

Figure 26. Weather balloon using radiosonde tracking instruments.

METEOROLOGY LABORATORY

Introduction

Mission and General Research Direction

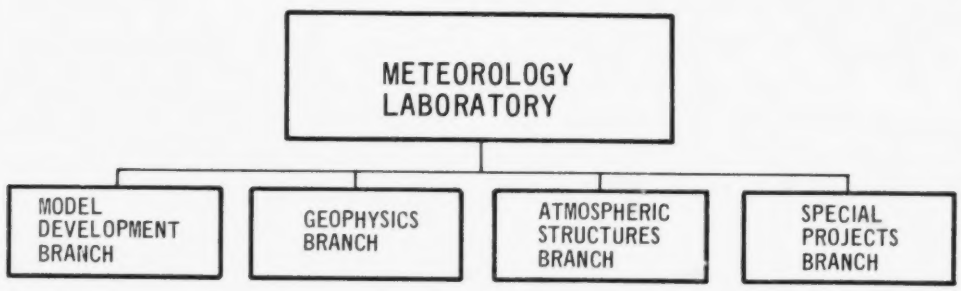
Much of EPA's research and development work in the atmospheric sciences focuses on air pollution meteorology, under the purview of the Meteorology Laboratory (MTL), which is EPA's center of excellence in air pollution meteorology for both research programs and operational support activities. The MTL consists of personnel from both EPA and the National Oceanic and Atmospheric Administration (NOAA), on assignment to EPA through a continuing (since 1955) interagency agreement.

The MTL program involves two general areas of activity: **research** activities aimed at defining and describing meteorological factors of prime importance to air pollution control, and **operational support** activities which apply meteorological principles to air pollution control programs. Through a combination of in-house, contract, and grant research programs, MTL carries out theoretical and experimental studies to improve the understanding of the physical-chemical processes affecting the transport, diffusion, transformations, and ultimate disposition of air pollutants in and from the atmosphere, on scales ranging from local to global. MTL provides technical information, observational and forecasting support, and consultation on all meteorological aspects of air pollution control to EPA components external to the Laboratory.

Organization

The Meteorology Laboratory, within the organizational framework below, develops and conducts research concerned with the meteorological aspects of air pollution. Techniques and methodologies are developed and improved to determine and forecast air pollution potential and climatology. MTL also develops analytical diffusion models to predict the temporal and spatial distribution of air pollutants. Studies are conducted on the effects of air pollutants on the geophysical processes of weather and climate as well as the energy balance of the earth-atmosphere system. Also developed are remote sensing techniques for measuring meteorological parameters in urban areas. Additionally, the Laboratory provides meteorological services to other EPA activities as required.

The Model Development Branch develops and applies analytical formulations to estimate the relationship between any arbitrary distribution of sources and the resultant air quality. It conducts theoretical and experi-



mental studies of the physical processes affecting the transformation and ultimate disposition of air pollutants in and from the atmosphere.

The Geophysics Branch develops and applies methods, procedures, and techniques of meteorological processing, analysis, and presentation to provide information on local, regional, and national air pollution potential climatology. It derives nationwide climatology of air pollutant concentrations using historical air quality and meteorological data together with transport and diffusion models. Techniques are developed for the forecasting of air pollutant concentrations and air pollution potential. Short- and long-term effects of air pollutants on geophysical processes of weather and climate are studied, as well as the energy balance of the earth-atmosphere system.

The Atmospheric Structures Branch conducts research on physical processes and dynamic structure of the lower atmosphere over urban and non-urban areas using field experiments and observations together with theoretical calculations. It conducts research on the atmospheric impact of pollutants and heat emissions from large sources. It develops remote sensing techniques for measuring the vertical and horizontal distribution of meteorological parameters.

The Special Projects Branch develops and provides meteorological assistance and support to the Office of Air and Water Programs, EPA Regional Offices, and State and local agencies. It also provides liaison between the NERC and outside organizations with additional meteorological interests and needs.

Table 9. SUMMARY OF RESOURCES FOR METEOROLOGY LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000)	FY 1972 Positions EPA/NOAA	FY 1973 ($000)	FY 1973 Positions EPA/NOAA
Regional Air Pollution Study (RAPS)	-	-	3,290	3/11
Meteorological research	3,777	13/49	2,906	12/39
Totals	3,777	13/49	6,196	15/50

Physical Facilities

The MTL is located in the National Center for Health Statistics (NCHS) Building in the Research Triangle Park, North Carolina. On site is a 30-foot-high observation platform used to measure radiation. A Fluid Modeling Facility (FMF), consisting of water and air channels, is being designed under contract; efforts are under way to locate a suitable site for the FMF in the NERC/RTP complex. Construction of the FMF is expected to begin in 1973, with wind tunnel operations scheduled for late 1973 or early 1974; the water channel is scheduled for completion in 1975. The FMF will permit MTL scientists to model complex flow patterns such as transport and diffusion of pollutants around buildings, mountains, and valleys.

Unique equipment, developed with MTL support and now used by MTL, includes three remote-sensing instruments:

- A truck-mounted mobile lidar (laser/radar) system can be used to measure the atmospheric backscattering of light, which can be related to atmospheric turbidity. A measure of the vertical profile of atmospheric backscattering by the lidar will provide useful information on the three-dimensional atmospheric aerosol structure, on mixing depth, and on atmospheric stability.
- A thermasonde radiometric temperature-sensing system, providing information on the vertical profile of the atmosphere to 1500 meters above site location, is a passive system that measures the naturally occurring microwave energy caused by the permanent magnet movement of oxygen molecules in the atmosphere. Measurement of the microwave energy is equated to air

temperature through appropriate scanning of the radiometer and by mathematical data inversion schemes. The Mark I system was delivered to EPA in February 1969 and has been used by MTL in several field programs. A more sensitive and completely automatic Mark II system is currently being tested. The thermasonde provides information on mixing depth and atmospheric stability, meteorological parameters used in diffusion models, and air pollution potential forecasting.

- A simple, compact sunphotometer can be used to measure the atmospheric turbidity coefficient (loss of light due to both scattering and absorption of both aerosols and gases in a column between the instrument and the sun) at both 380- and 500-nm wavelengths. In a program administered by MTL since 1960, the sunphotometer has been used in a global network of stations to determine the worldwide background and trends of turbidity as a basis for the study of long-term trends in global pollution.

Major Program Areas

Summary of Present Programs

Major program areas of the MTL include the development of air quality simulation models, a program of single-source simulation studies, geophysical studies, meteorological support, and the Regional Air Pollution Study.

Consistent with the development of air quality simulation modeling is the development of a hierarchy of general urban-regional diffusion models. This effort involves an assessment of new empirical and numerical simulation modeling techniques and validations of newly developed urban simulation models. Also related is the development of remote sensing instruments for measuring mixing depth, temperature profiles, and relative aerosol concentration distributions in the planetary boundary.

The single-source studies conducted by MTL describe the dispersion and physicochemical changes of effluents (pollutants, water vapor, and heat) from large single sources. The studies involve developing tall-stack-plume dispersion models and developing and evaluating natural precipitation-scavenging models that describe the pollutant washout (from large power-generating plants) that contributes to ground-level contamination.

The effects of air pollutants on weather and climate are major concerns of the geophysical studies. To measure these effects, MTL administers a global atmospheric turbidity network that assesses trends in global pollution. Other supporting studies include identifying regions likely to have "acid rain" problems, determining the degree of dependence of urban-rural radiation (solar, terrestrial, and global) differences on atmospheric pollution and urban morphology, and describing and continually updating air pollution potential climatology for the United States, applicable to land-use activities and strategies.

The meteorological support studies provide technical information and consultation on all meteorological aspects of pollution control to EPA components external to MTL. This assistance includes technical backup to meteorologists assigned to Regional Offices, meteorological forecasts and weather data to Regional activities during emergency situations, and support to States and local control officials in the form of necessary data and evaluation for abatement and compliance actions. To provide accurate assistance, MTL maintains liaison with the National Weather Service.

The Regional Air Pollution Study, a 5-year research program initiated in July 1972, will bring together a number of research areas: air pollution effects, atmospheric processes, monitoring and analytical methods, ambient

air quality surveillance, and source characterization and control strategies. To relate the application of various control strategies to their effectiveness in improving air quality, improved scientific and technical inputs are needed. These inputs are to be obtained through a series of field investigations (over distances of about 100 kilometers). These field studies will comprise the RAPS which will be conducted in the St. Louis area; EPA will coordinate RAPS with the experiments of private groups and other Federal agencies in the area.

Major Accomplishments

The Laboratory's accomplishments over the past 1-1/2 years are summarized in four major areas.

- **Air Quality Simulation Modeling**

Validating an urban diffusion model that describes the distribution of automotive-generated CO.

Evaluating a long-term prediction model applicable to Ankara, Turkey.

Developing and initially evaluating three air quality simulation models for chemically active pollutants.

Completing a sensitivity analysis of available Gaussian dispersion models.

Completing a comparative study showing that the Climatological Dispersion Model performs better than the Air Quality Display Model for certain problems.

Developing a short-term dispersion model to evaluate the necessity of controlling emissions from aircraft.

Developing a mathematical model for relating air quality measurements to air quality standards.

Developing and testing the performance of the Mark II thermasonde radiometer, capable of remotely depicting mixing depths and vertical temperature profiles within the planetary boundary layer (lowest 5000 feet).

Testing the performance in Denver of an acoustic sounding system, capable of providing useful information on the turbulence and temperature structure within the planetary boundary layer.

- **Single-Source Studies**

Completing field tests under the auspices of the Large Power Plant Effluent Study (LAPPES) in Western Pennsylvania, yielding a large body of data currently being analyzed to describe the ultimate disposition of pollutants emitted from stacks 700 to 1000 feet high.

Completing studies indicating that absorption/desorption processes are important in the natural precipitation-scavenging of SO_2 in the atmosphere.

- **Geophysical Study**

Demonstrating the feasibility of using satellites as platforms for measuring atmospheric turbidity and albedo on a global scale.

Documenting climatological information on dispersion parameters for the contiguous United States.

Using new dual-wavelength (380 and 500 nm) sunphotometers at 44 stations around the world for measuring atmospheric turbidity as geophysical indicators of global pollution trends in the atmosphere.

Implementing an urban-rural radiation study at NERC/RTP as a prelude to a more extensive study of St. Louis under the auspices of RAPS.

Implementing a precipitation chemistry network involving 10 sampling stations at National Weather Service sites, supported jointly with NERC/RTP's Chemistry and Physics Laboratory.

- **Meteorological Support**

Supporting EPA's Emergency Operations Control Center (EOCC) during a local stagnation episode in Birmingham, Alabama,

and during the chlorine barge incident in Louisville, Kentucky. (Special weather forecasts and meteorological observations were taken during these periods.)

Providing air pollution climatological data to the Southwest Energy Study Report prepared by NOAA.

Providing meteorological support to the Mt. Storm and Parkersburg, W.Va., abatement conferences.

Hosting a meeting of the World Meteorological Organization Executive Committee's Expert Panel on Meteorological Aspects of Air Pollution in April 1972. (The Panel completed details of a global air pollution monitoring network proposal presented to the U.N. Conference on Human Environment in June 1972.)

Future Research Emphasis

Future emphasis of the air quality simulation modeling studies will include the validation of simulation models for chemically reactive pollutants and the evaluation of new modeling techniques. The Physical Modeling Facility is expected to be implemented in 1973 with the completion of a wind tunnel, followed by the construction of a water channel in 1974. Simulation models also will be evaluated under the auspices of the Regional Air Pollution Study in St. Louis. Programs will be devoted to solving problems on plume downwash around buildings, topographical effects on plume rise and diffusion, air-water interactions involving pollutant transformations, small-scale dispersion from traffic, and environmental impact of elevated or depressed highways and airports.

A User's Network for Environmental Quality Modeling will be developed and implemented in 1973; this concept involves using the latest technology in computer hardware and software to establish a library of simulation models and related data that are readily available to all potential users.

Future emphasis of the single-source studies will consider the heat and moisture budgets of a power plant cooling pond, to determine the contributions of sensible heat and moisture to the atmosphere from such a cooling facility. Natural precipitation washout studies will be carried out in the St. Louis area under the RAPS program.

Current RAPS program planning calls for the prime contractor to be selected and to begin operations in the St. Louis area by early 1973. The network of measuring stations should be in operation by early 1974. Inventory, meteorological, and air quality characterization studies, begun during the summer of 1972, will be assumed by the contractor and continued during the period of the study. Although field activity is expected to be completed by the end of 1977, analysis of RAPS data may continue for several more years. The impact of RAPS information on air pollution simulation models should begin to be felt as early as spring of 1974, shortly after the network begins to produce adequate data for model verification. Verified and updated air quality models will be made available to State and local air pollution agencies as quickly as possible.

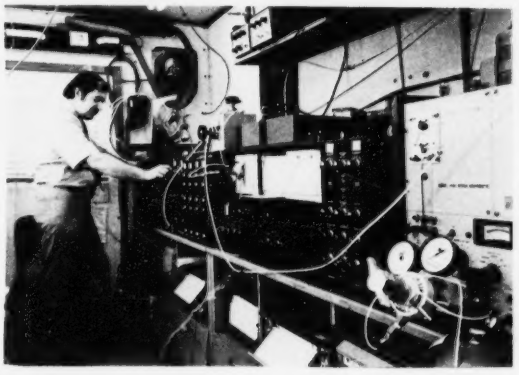


Figure 27. Mobile monitoring equipment for measurement of atmospheric concentrations of ozone, hydrocarbons, nitrogen oxides, and sulfur dioxide.

Figure 28. Demonstration facility housing a variety of air monitoring and measurement equipment. Site is used in training programs concerned with operation and use of such equipment.

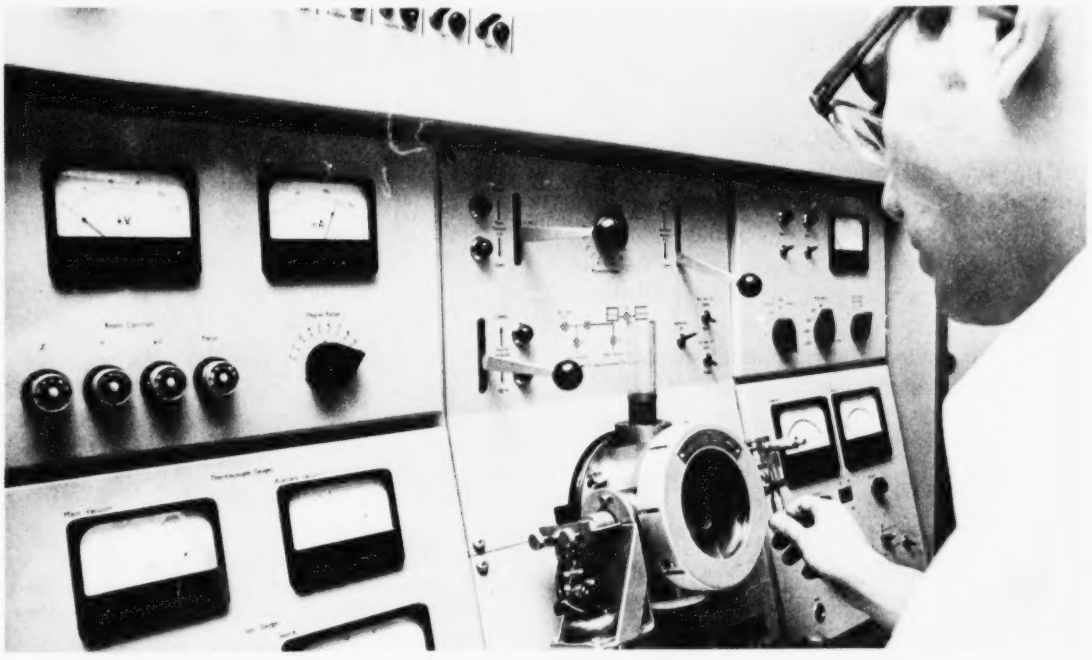


Figure 29. Spark source mass spectrometer for environmental sample analysis.

QUALITY ASSURANCE AND ENVIRONMENTAL MONITORING LABORATORY

Introduction

Mission and General Research Direction

The basic mission of the Quality Assurance and Environmental Monitoring Laboratory (QAEML), formerly the Division of Atmospheric Surveillance, is to acquire the accurate and valid aerometric (or other environmental) data required to support decisions relating to air pollution or to general environmental quality, in the areas of air resource management, standards setting, criteria development, compliance and enforcement, episode control, and preferred paths for source emissions control.

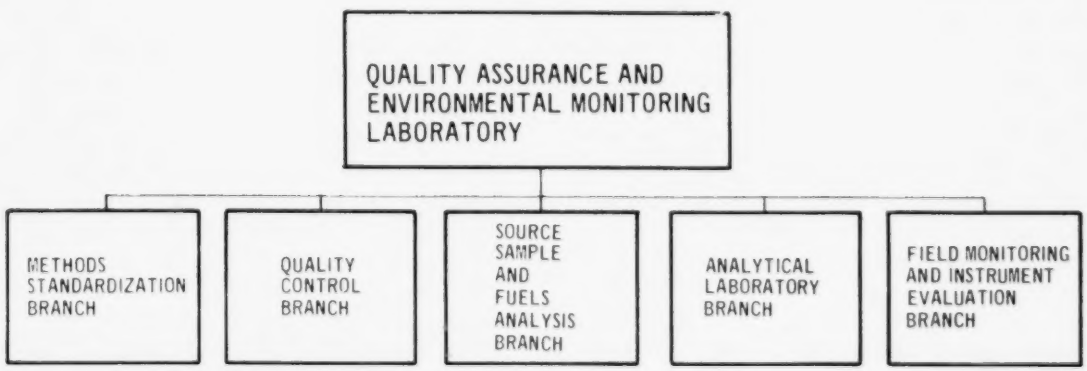
This mission involves applying standard methodology and using adequate quality control procedures to ensure the production of a high-quality product. The QAEML provides standard methods of sampling and analysis, as well as quality control guidelines and procedures and technical assistance, to maximize the validity and comparability of data generated by all agencies sharing this basic mission.

Emphasis has been, and will continue to be, placed on gathering valid air quality and related data and on developing (refining) methodology for measuring pollutants.

Organization

The QAEML – operating in five Branches – provides analytical methods standardization, quality control, equivalency evaluation, and specialized field monitoring and analytical support to EPA's Regional Offices, the Office of Enforcement and General Counsel (OEGC), the Office of Air and Water Programs (OAWP), and other NERC/RTP components. It is responsible for field-evaluating commercial air pollution instrumentation and carries out mathematical and statistical evaluation and report preparation of internally generated data.

The Methods Standardization Branch program involves methods evaluation, procedure revision, and collaborative testing that results in publication of standard analytical methods


QUALITY ASSURANCE AND ENVIRONMENTAL MONITORING LABORATORY
METHODS STANDARDIZATION BRANCH
QUALITY CONTROL BRANCH
SOURCE SAMPLE AND FUELS ANALYSIS BRANCH
ANALYTICAL LABORATORY BRANCH
FIELD MONITORING AND INSTRUMENT EVALUATION BRANCH

for ambient air as well as for stationary and mobile sources. The Branch develops standard reference materials for use in methods development and standardization activities.

The Quality Control Branch provides an analytical quality control program for NERC/RTP laboratories and quality control guidance to Regional Offices and State and local laboratories. It develops standard reference materials and delivery systems for use in quality control activities and equivalency evaluations.

The Source Sample and Fuels Analysis Branch provides analytical laboratory support to source sampling activities carried out by OAWP. This includes technical assistance, as well as liaison between source sampling and analysis methodology, to provide valid data for developing new-source performance standards or hazardous pollutant emission standards. It provides analytical capability for determining the chemical and physical composition of fuel and fuel additives. It also performs analyses to determine trace elements in a variety of environmental samples.

The Analytical Laboratory Branch provides technical support and specialized training to EPA Regional Offices and State and local laboratories. It develops new methods, modifies existing methods, and provides analytical services to support ongoing activities, including research monitoring. It provides analytical laboratory support for short-term and special environmental studies to support EPA enforcement activities.

The Field Monitoring and Instrument Evaluation Branch provides specialized support and training to OAWP, OEGC, and EPA Regional Offices. It field-evaluates new and improved techniques for collecting environmental samples and for the continuous measurement of environmental pollutants. It is responsible within NERC/RTP for field-testing and evaluating new and improved analytical instruments developed in other NERC laboratories. It is also responsible for the evaluation of equivalency of candidate methods and instruments to reference and standard methods.

Table 10. SUMMARY OF RESOURCES FOR QUALITY ASSURANCE AND ENVIRONMENTAL MONITORING LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000)/Positions	FY 1973 ($000)/Positions
Monitoring data audit and review	685/23	233/8
Advanced monitoring techniques	2,544/80	1,682/68
Monitoring quality assurance	–	1,581/16
Totals	3,229/103	3,496/92

Physical Facilities

QAEML personnel occupy office, shop, and laboratory space in the NERC/RTP and in the Durham Air Monitoring and Demonstration Facility. The Laboratory also operates six Continuous Air Monitoring Program (CAMP) stations in Washington, D.C., Philadelphia, Cincinnati, Chicago, St. Louis, and Denver. All monitoring and analytical activities are either performed at, or directed from, NERC/RTP.

The Laboratory operates a number of unusual or major items of analytical equipment:

- The Automated Laboratory Data Analysis System (ALDAS) – Scheduled for completion in late 1972, this system will facilitate rapid and accurate measurement of trace-element levels in environmental samples. It will receive, store, and process data outputs from direct-reading analytical instruments including an Ainsworth balance, an atomic absorption spectrometer, and an optical emission spectrometer. (Several components were in use prior to system completion.)

- A computerized and automated X-ray fluorescent spectrometer – Currently being calibrated, this equipment can also be used to process data from other sources.
- An anodic stripping voltameter – This instrument has an extremely sensitive reading capability (in nanograms) for up to 12 elements, predominantly the heavy metals.
- A spectrometer system using an automated direct-reading absorption spectrophotometer and recording colorimeters – This system is used to analyze over 60,000 samples a year for gaseous pollutants (SO_2, NO_2) and nonmetallic ions ($SO_4^=$, NO_3^-, NH_4^+) extracted from suspended particulates.
- A system capable of making some 4,000 determinations per year of pesticides and polychloro-biphenyls in ambient air samples – This system consists of two gas chromatographs with electron capture, flame ionization, flame photometric thermionic emission, thermal conductivity, electrolytic conductivity detectors, and a computer integrator; a high-pressure liquid chromatograph; and a luminescence spectrophotometer.
- A spark-source mass spectrometer (believed to be the only one of its specific type of less than six of all types in the Nation) – Installed during the first quarter of FY 73, this instrument is used for trace analysis of up to 80 elements in fuels, source samples, and other environmental samples.
- Neutron activation counting equipment – Used in conjunction with N.C. State University's high-flux research reactor, this equipment and its methodology complement the capabilities of the Laboratory's spark-source mass spectrometer.

Major Program Areas

Summary of Present Programs

Major programs of the Quality Assurance and Environmental Monitoring Laboratory include continued monitoring data audit and review, development of advanced monitoring techniques, and monitoring quality assurance.

The monitoring data audit and review program consists of improving data acquisition and utilization in support of in-house standardization; determining the equivalency of methodology; quality control activities; and technically assisting and supporting OAWP, OEGC, EOCC, OR & M, and Regional Offices as well as State and local quality control agencies.

The field monitoring and analytical support program includes the analysis of fuels, fuel additives, and source samples. The Laboratory assists State and local agencies by operating a variety of networks (suspended particulate, gas, and continuous monitoring) and by participating in special environmental projects, e.g., the Southwest Energy Study (SWES) and the Regional Air Pollution Study. Since these operations produce data to support investigations of complex pollutant problems, development of criteria documents, and definition of problem areas, they require application of a wide variety of highly sophisticated analytical methods and, on occasion, development of special-purpose methods.

Results of continuous monitoring for CO, SO_2, NO, NO_2, O_3, CH_4, and total hydrocarbons, conducted in six large cities, are used to define diurnal and seasonal variations as well as long-term trends. Samples of suspended particulates collected by the 275-station National Air Surveillance Network are analyzed for total mass concentration, as well as for such individual pollutants as lead, beryllium, chromium, nickel, and 15 or so other trace elements. Integrated 24-hour samples collected at the 190 Gas Sampling Network stations are analyzed for SO_2 and NO_2 to provide data also used to determine long-range trends.

An intensive 90-day monitoring program, utilizing newly developed and commercially available (but inadequately field-tested) instrumentation, was conducted in mid-1971. Ozone was measured continuously at 40 sites, and CO at 36 (not necessarily duplicated) sites. The data collected were used to determine the associated Air Quality Control Regions' (ACQR's) category (Priority I or III) with respect to the two pollutants. A similar program, to measure NO_2 in 42 AQCRs, was conducted late in 1972; the data collected will enable the AQCRs to be categorized (I or III) on the basis of NO_2 concentration.

Other significant nonroutine contributions of QAEML include completion of a study on indoor/outdoor pollutant relationships in high rise and air rights structures, development of methodology for determining mass concentration of asbestos in ambient air, development of a sampling and analysis method for airborne pesticides, development of two sampling and analysis methods for mercury in air, and provision of substantial data input into NAS "Biological Effects" documents on lead, chromium, vanadium, nickel, and manganese.

The advanced monitoring technique program also inaugurated a Nationwide Fuels Surveillance Program (gasoline, jet fuel, and heating fuels). Material analyzed is obtained through a nationwide fuels-collection network operated by the Regional Offices. A trace-element measurement program was developed in-house to handle all types of environmental samples, using neutron activation analysis and spark-source mass spectrometry. During this reporting period, major emphasis was placed on analyzing source emission samples collected by the Office of Air Quality Planning and Standards. Results of these analyses were used to set standards under Sections 111 and 112 of the Clean Air Act.

The Durham Air Monitoring and Demonstration Facility (DAMDF) is a focal point for demonstrating the use of continuous air monitoring instrumentation in monitoring the Nation's air quality. Individual on-the-job training is conducted to assist air pollution agencies in operating the equipment successfully. The DAMDF, also a field station for long-term evaluation of commercially available instrumentation, is used by NERC's Meteorology and Human Studies Laboratories.

The QAEML also technically supports the Office of Air Quality Planning and Standards by analyzing fossil fuels for hazardous and other pollutants. Samples of the different fuels are collected nationwide to provide a cross-section of materials. Analyses for hazardous and other pollutants provide the basic data for establishing and enforcing emission standards and for supporting various industry studies.

The monitoring quality assurance program has two major areas: evaluating and standardizing methods for measuring ambient air pollutants, and developing and implementing quality control programs.

Purposes of the former program are to evaluate and standardize methods included in the National Air Quality Standards (NAQS) and to develop standard reference materials for the methods. Each method is evaluated, collaboratively tested, and standardized according to a technically and statistically designed plan. Current activities include collaboratively testing the ozone method, developing plans for collaborative tests at stationary sources, continued testing of the pararosaniline SO_2 procedure, and developing standard reference materials.

The quality control program is aimed at developing guidelines, procedures, systems, protocols, and test materials for use in implementing intra- and inter-laboratory quality control that will ensure the production of high-quality environmental quality data. The program provides technical assistance in

implementing, coordinating, and evaluating quality control programs at EPA Regional Offices, NERCs, and State and local environmental laboratories. It also develops a referee analytical quality control laboratory.

Current significant activities include evaluation of a prototype standard gas delivery system; evaluation of a high-volume sampler standard calibration device; continuation of the development of quality assurance procedures for source emission sampling and analysis methods; and continuing encouragement of, and assistance in, the use of standard or equivalent methodology and acquisition of comparable environmental quality data by all agencies involved in the area of environmental quality evaluation.

Major Accomplishments

Major accomplishments of the Laboratory's monitoring data audit and review program are:

- Establishment of a nationwide air quality data management system that provides standard formats for storage and retrieval of data.
- Guides for use in the data management system (SAROAD).
- Establishment of a national data bank into which has been deposited the major portion of air quality data acquired by Federal, State, and local agencies. Standard computer programs for storage and retrieval of data have been made available, as have provisions for access to the data bank from remote terminals.

The major accomplishment of the monitoring quality assurance program is the completion of evaluation and collaborative tests of the **Federal Register** reference methods for SO_2 and CO. In other areas of the program, contracts were negotiated for developing first-generation guidelines and systems for instituting quality control in Regional, NERC, State, and local environmental monitoring programs. Also, methods have been devised for evaluating laboratory performance, and a performance survey was conducted of approximately 130 laboratories.

An inter-Laboratory/inter-Branch task group produced the document, **National Primary and Secondary Ambient Air Quality Standards – Proposed Regulations for Equivalent Methods**. This to-be-published document provides detailed procedures and specifications for defining and determining equivalency of methods with respect to "reference methods" for the measurement of pollutant concentrations published in the **Federal Register** of November 25, 1971 (Volume 3b, page 22384).

Future Research Emphasis

Future emphasis of the monitoring data audit and review program will be on accelerating design and implementation programs for improving the acquisition, processing, auditing, and utilization of data in support of standardization and equivalency determination activities and in the operation of a quality control program. Support in these areas to OAWP, OEGC, EOCC, OR&M, Regional Offices, and State and local agencies – in regard to operating surveillance networks – will be provided on an increasing level.

In the future, greater emphasis relating to field monitoring and analytical support will be placed on investigations and special studies of the development of new and improved methods for the more-difficult-to-analyze pollutants, for new-generation pollutants, for ambient-air/source relationships, for particle size distribution (particularly with respect to trace metals), and for increased support of SWES and RAPS. Evaluation of several different methods for collecting and measuring ambient NO_2 will be given highest priority. In the area of special field studies, emphasis will be on the successful continuation of the Western Smelter/SO_2 study, field

evaluation of instrumentation, and acceleration of the decentralization plan for transferring routine total suspended particulate and gas network operations to the respective Regional Surveillance and Analysis Divisions.

Future plans will also emphasize continued analytical support of the Office of Air Quality Planning and Standards for setting Federal standards and increased support of the Office of Enforcement for the enforcement of standards. The trace-element measurement program will be expanded in two areas: analysis services will be provided to other NERC/RTP Laboratories; and source emission samples will be separated into several particle-size ranges prior to analysis. Future plans also include implementing the final phase of the Nationwide Fuels Surveillance Program to include the analysis of fuel additives.

Emphasis in the monitoring quality assurance program will be on collaboratively testing and standardizing methods for ozone, NO_2, hydrocarbons, SO_2 (24-hour sampling), and emissions from stationary sources (nitric acid plants, sulfuric acid plants, incinerators, cement plants, chlor-alkali plants, non-ferrous smelters, and fossil-fuel-fired-power-generating plants). A program will be initiated to test methods for light-duty-vehicle emissions.

In the immediate future, emphasis will be placed on guidelines and procedures for intra-laboratory quality control programs and measurement systems for stationary and mobile source emissions, fuels, and raw materials. The development of a test-gas generation and delivery system will be accelerated. Specifications will be developed for standard materials used in environmental monitoring (e.g., filters and gases) as a major step in implementing quality control programs.

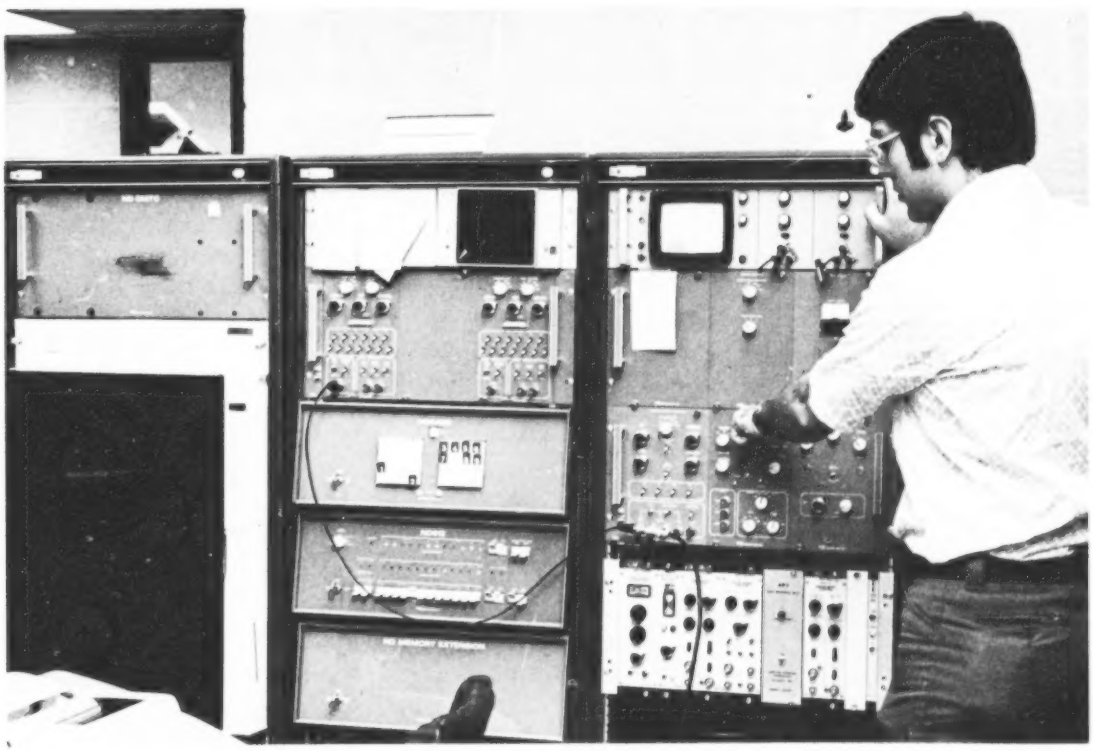


Figure 30. Neutron activation counting instrumentation.

Figure 31. Exposure chamber for low-level microwave irradiation studies of Chinese hamsters.

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EASTERN ENVIRONMENTAL RADIATION LABORATORY

Introduction

Mission and General Research Direction

As an associate laboratory of NERC/RTP, the Eastern Environmental Radiation Laboratory (EERL) is one of two EPA field radiation laboratories with responsibility for determining the impact of radiation on the environment. NERC/Las Vegas (formerly the Western Environmental Research Laboratory) is concerned with the Western States. EERL is responsible for EPA Regions I through V, including all 27 States east of the Mississippi River.

A major function of the Laboratory is its research program in both radiation biological effects and analytical methodology. Another primary function is to provide technical assistance to the radiological health programs of State and local health departments within the regions it serves, as well as other Federal agencies. Included is on-the-job training of health personnel, expertise in radiation surveillance and analyses, and personnel and associated equipment for coping with radiation accidents.

This Report describes the overall activities of the Eastern Environmental Radiation Laboratory, while specifically discussing only those projects related to NERC/RTP's programs, i.e., those conducted by the Radiation Bioeffects Research Branch and the Physical Sciences Research Branch.

Among the programs currently being conducted by EERL are:

- Determination of biological hazards associated with ionizing and non-ionizing radiation so that risks can be assessed and evaluated.
- Research and development of radioanalytical and stable-element determinations, and maintaining operable all of the radiochemical procedures used at the Laboratory.
- Identification of components of man's ecosystem in which radionuclides collect, and the quantitative assessment of the significance of such pooling on man and his environment.
- Maintenance of a record of radioactive concentrations in various media in connection with network sampling programs as well as special environmental sampling programs, using sampling networks for air, water, soil, milk, vegetation, and food.

Organization

As shown in the organization chart, EERL consists of four offices and four branches in addition to administrative offices.

The Radiation Bioeffects Research Branch performs research in both ionizing and non-ionizing radiation, specifically to obtain data to be utilized in formulation of krypton-85 and microwave exposure standards. It conducts research into the biological effects of microwave radiation for the purpose of determining the presence or absence of a hazard. It is also investigating biological effects resulting from krypton-85 exposure.

The Physical Sciences Research Branch performs research and development on projects requiring radioanalytical and stable-element analysis. It evaluates and develops chemical methods for use in programs conducted by the Laboratory.

The Nuclear Facilities Research Branch evaluates the impact of nuclear facilities on man and his environment. Studies are conducted to identify sources and quantities of radioactive effluents from these facilities, and to determine the transport parameters and accumulation of these effluents in environmental pathways. It uses data from this activity to assess any potential radiation exposure to man.

The Analytical Services Branch conducts EERL's environmental monitoring and surveillance activities and provides analytical and electronic maintenance support to the other Laboratory Branches. Its chief responsibility is the operation of the National Environmental Radiation Surveillance Networks, which include separate milk, food, water, and bone networks. It provides technical assistance to other Federal and State agencies in the form of cross-check services, on-the-job training, and special-sample analyses.

The Office of Quality Control and States Assistance confirms the validity of analytical results through duplicate analysis to measure precision, and through spiked analysis to measure accuracy. It conducts an active quality control program with various States within EPA Regions I through V. Coordinating with the Regional Offices, the Office fosters a mutual exchange of scientific ideas and technological advancement between the States and the Laboratory.

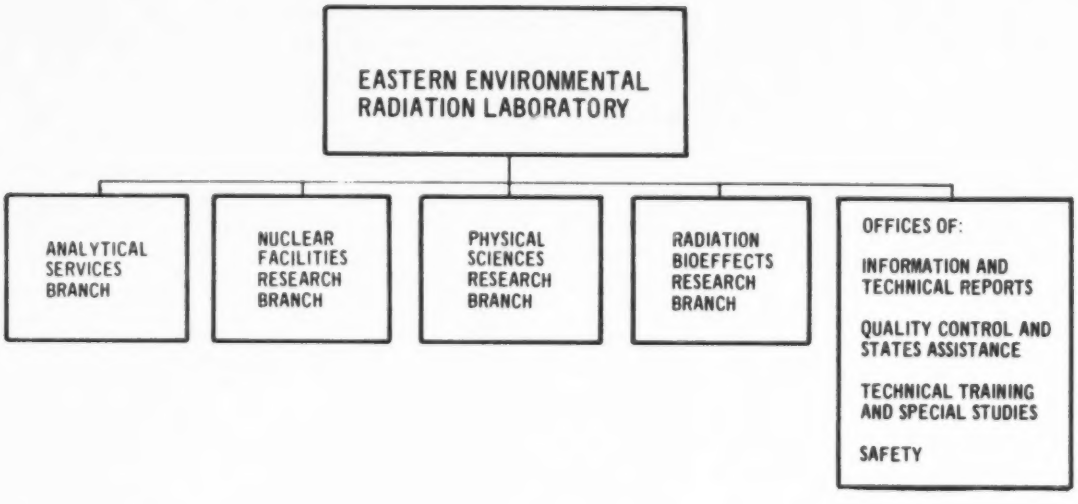
Table 11. SUMMARY OF RESOURCES FOR EASTERN ENVIRONMENTAL RADIATION LABORATORY, NERC/RTP, FOR FISCAL YEARS 1972 AND 1973

Category	FY 1972 ($000)/Positions	FY 1972 ($000)/Positions
Radiation health effects research	365/14	445/25
Monitoring quality assurance	328/20	277/18
Program support	80/0	84/0
Totals	773/34	806/43

Physical Facilities

The variety of facilities at EERL allows maximum flexibility in Laboratory operations. These facilities consist of 28 buildings (approximately 50,000 square feet) and include:

- Chemistry and radiological laboratories.



- Facilities for extensive biological studies and for maintaining animal colonies for these studies.
- Elaborate counting equipment for complete radionuclide analysis, and the capability for both maintaining this equipment and developing new instrumentation for Laboratory programs.
- Modern training facilities – a classroom accommodating 50 students for classroom studies (or 150 persons for lectures or films) and two adjoining student laboratories.
- A large greenhouse and climate control chambers.
- An extensive library to serve the technical staff.
- Maintenance and repair shops capable of remodeling buildings and constructing laboratory and research facilities and equipment.

Major Program Areas

Summary of Present Programs

The programs conducted at EERL are designed to confront the problems of pollution contamination caused by radiation. Studies conducted by the Radiation Bioeffects Research Branch and the Physical Sciences Research Branch are of specific interest to NERC/RTP and are described in greater detail below.

The Radiation Bioeffects Research Branch has concentrated its efforts on two projects. Information obtained in the Microwave Cytogenetics Study indicates that microwave radiation can induce chromosome abnormalities. Mature Chinese hamsters have been exposed to 200 MW/cm^2 for different time intervals at a frequency of 2432 ± 4 MHz. The results from chromosome analysis indicate that, for the power density and exposure times employed, there is a significantly higher percentage aberration for irradiated animals than for controls. This was true for all exposure times and for all tissues. Investigations at much lower power densities, however, are required to determine possible effects at ambient levels.

Of two other microwave projects underway, one involves decreasing the power density from 200 to 15 MW/cm^2 and determining the cytogenetic effects and their change corresponding to variable power density. Also ongoing is a program to determine the effects of microwave radiation on offspring of irradiated parents.

The Krypton-85 Study involves investigating the physiological behavior and radiation effects of krypton-85 in living animals. Krypton-85 is a fission product noble gas produced in nuclear power production and is being released to the atmosphere in large quantities. The data obtained from this research will provide EPA with a realistic assessment of the hazards associated with krypton-85 exposure. These data will be used to develop credible standards for krypton-85 concentrations in ambient air, and for nuclear facilities that release krypton-85 to the environment. Studies presently being pursued include:

- Determination of **in vivo** whole-body-partition coefficients for krypton-85 from air to tissue for guinea pigs and the kinetic parameters involved in saturation and desaturation of the body with krypton-85, and the determination of individual organ air-to-tissue partition coefficients for krypton-85 in guinea pigs for the most important organs and tissues.
- In another study, most of the necessary data have been collected to determine the median lethal exposure to krypton-85 for guinea pigs exposed via the respiratory route with the outside of the body protected. Completion of a sealed exposure chamber will provide for the determination of the median lethal exposure to krypton-85 for guinea pigs, rats, and hamsters exposed "whole body" in beta-infinite-cloud geometry.

Efforts of the Physical Sciences Research Branch in 1972 focused on chemical and instrumental techniques for isolating and measuring a variety of individual radionuclides from environmental samples. Of particular interest were separation and measurement of tritium, carbon-14, krypton-85, promethium-147, and neptunium-237.

A series of radiochemical analytical procedures designed for aqueous samples and compiled by the Radiochemistry and Nuclear Engineering Laboratory, EPA, Cincinnati, were evaluated at EERL prior to their publication as part of an EPA surveillance guide.

Procedures, developed for plutonium and neptunium separation from environmental samples, include the adaption of liquid ion-exchange technology for the separation of these actinides from filters, biota, and soil using triisoctylamine. Preliminary successful investigations were carried out on the separation and radioassay of curium from environmental samples. Curium is being considered for a power source for future space exploration. Using curium-244 as an experimental tracer, 70 percent yields were obtained by extraction with di-n-butyl-N, N-diethyl carbamyl phosphonate (DDCP).

The xylene/Triton N-101 emulsion system, used routinely at this Laboratory for liquid scintillation counting, can be used only at or near 20°C. Based on requests from users of the refrigerated counters for an emulsion system for use at lower temperatures (0° to 10°C), a mixture was found which had the desirable properties below 10°C.

Instrumentation was developed to meet requirements for low-level detection capability. A Pm-147 whole-body counter, utilizing a large but thin sodium iodide (T1) crystal, was designed to detect the low-energy bremsstrahlung radiation produced by Pm-147 absorbed by the body. A tritium monitor, employing a scintillator cell and multiplier photo tubes as a detector, was developed to replace the bulky and complicated gas systems which often give erroneous readings. Advantages of this monitor are portability, energy discrimination, and ability to monitor both air and water at levels well below the maximum permissible concentrations of tritium.

Major Accomplishments

EERL's major accomplishments since 1971-1972 have been in direct support of EPA's responsibilities for improving the Nation's environment. Whether in research and monitoring or in related areas, EERL's programs are concerned with results that can be directly applied to solving existing problems. These accomplishments include:

- The design, construction, and evaluation of a microwave irradiation facility (maximum error of ± 18 percent at 200 MW/cm_2 power density).
- The conclusion that microwave radiation can induce chromosome abnormalities, based on the exposure of mature hamsters at 200 MW/cm_2 at a frequency of 2432 ± 4 MHz.
- The development of krypton-85 analytical procedures and establishment of a krypton-85 sampling network.
- The evaluation of the biological effects of krypton-85.
- The evaluation of luminous compounds (tritium and promethium-147) in paint.
- The development and standardization of radiochemical procedures for monitoring nuclear reactor effluents.
- The development of a radiological emergency response capability.
- Continued operation of the National Environmental Radiation Surveillance Networks for monitoring the Nation's air, water, milk, food, and vegetation.

Future Research Emphasis

EERL's projected work plans include continuing existing major projects to achieve the Laboratory goals just described.

Microwave Radiation. Continued investigation of microwave radiation effects will include studies of biological effects of pulsed versus continuous-wave microwave radiation, chronic exposure with low power density for long periods of time, frequency sensitivity of biological systems to the most commonly used microwave frequencies, and biochemical changes which might be induced by microwave radiation.

Krypton-85. Plans for the immediate future call for completing the Tissue Distribution and Internal Lethality Studies, beginning exposures for the Whole-Body Lethality Study, and studying the hematology and pathology associated with a median lethal exposure via respiration. Long-term plans include hematological and pathological studies on guinea pigs exposed at LD_{50} levels of krypton-85, acute-exposure studies of guinea pigs, and chronic-exposure studies of rats and hamsters (including cytogenic effects on hamsters) in a beta-infinite-cloud geometry.

Radiochemical Methodology Development. Future programs in this area will include the continuation of methods development and related studies for the radionuclide analysis of environmental samples. These studies will involve:

- Establishing tritium and carbon-14 methodology for food, vegetation, and biota components for the surveillance programs.
- Expanding radiochemical and instrumental methodology to include other nuclides, e.g., ^{55}Fe, ^{89}Sr, ^{90}Sr, ^{129}I, and ^{131}I in food, vegetation, and other biota samples.
- Designing and establishing criteria for operational surveillance networks for food and vegetation samples.

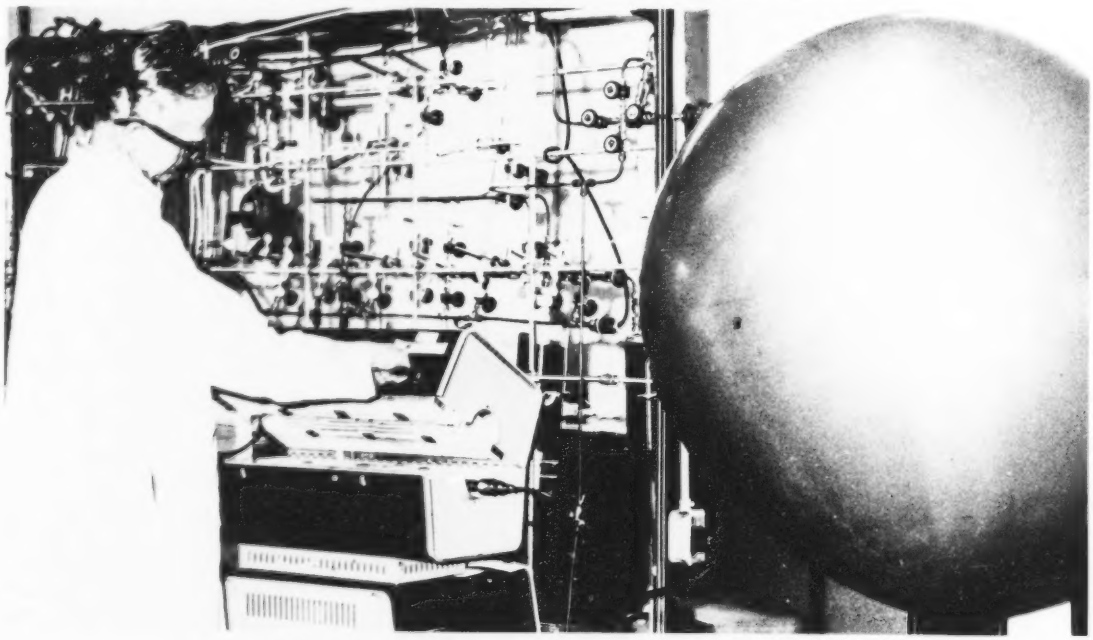


Figure 32. Equipment for rapid determination of krypton-85 in air.

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